THE AFRICAN REPUBLIC OF LIBERIA

AND THE BELGIAN CONGO

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THE AFRICAN REPUBLIC OF LIBERIA AND THE BELGIAN CONGO

Based On The Observations Made and Material Collected During The

√HARVARD AFRICAN EXPEDITION
1926-1927

EDITED BY RICHARD P. STRONG

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Volume I

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TO

HARVEY S. FIRESTONE

WHO HAS DONE SO MUCH
FOR THE DEVELOPMENT OF THE COUNTRY OF LIBERIA
AND FOR THE WELFARE OF ITS INHABITANTS

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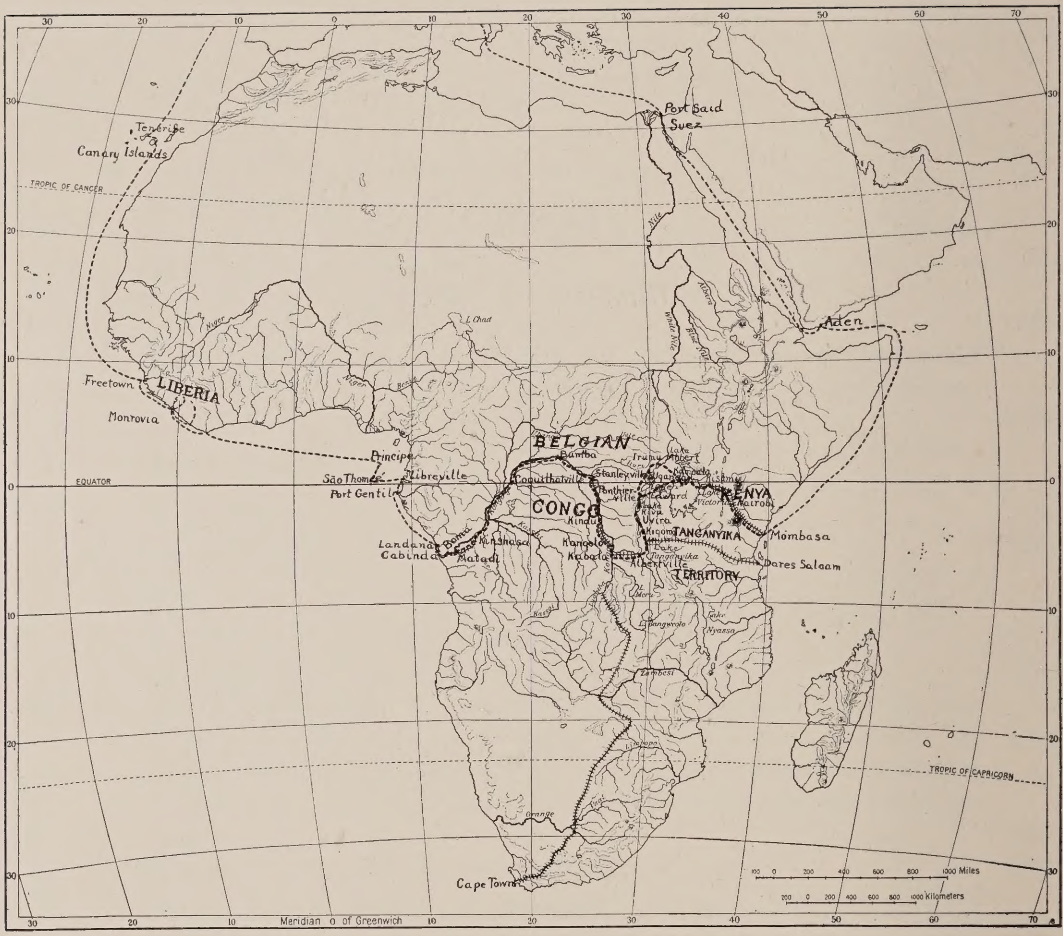
PART I

BY RICHARD P. STRONG


Tenerife
Canary Islands
Port Said
Suez
TROPIC OF CANCER
Nile
Aden
L. Chad
Niger
Freetown
LIBERIA
Monrovia
BELGIAN
CONGO
Principe
São Thomé
Libreville
Port Gentil
EQUATOR
Landana
Cabinda
Boma
Matadi
Kinshasa
Coquilhatville
Bumba
Stanleyville
Ponthierville
Kindu
Kongolo
Kabalo
Albertville
Uvira
Kigoma
TANGANYIKA
TERRITORY
KENYA
Kisumu
Nairobi
Mombasa
Dares Salaam
Lake Albert
Kampala
Lake Victoria
Lake Tanganyika
Lake Nyassa
Zambesi
Limpopo
Orange
Vaal
Cape Town
TROPIC OF CAPRICORN
Meridian 0 of Greenwich
Miles
Kilometers

Map No. I. — Dotted line indicates general itinerary of the Expedition

I

INTRODUCTION

The Harvard African Expedition of 1926–1927 was planned for the purpose of making a biological and medical survey of Liberia, which apparently was that country of Africa about which the least was known in those respects. It was also planned, after the survey was completed, to cross the continent of Africa from the west to the east coast, travelling particularly through the Belgian Congo, and to make comparative studies in these regions. This program was carried out. Map I roughly illustrates the general routes followed by the Expedition.

The members of the Expedition besides myself were Dr. George C. Shattuck, Assistant Professor of Tropical Medicine, Clinician; Dr. Max Theiler, Instructor in Tropical Medicine, Laboratory Assistant; Dr. Joseph C. Bequaert, Assistant Professor of Entomology, Entomologist; Dr. David H. Linder (Ph.D., Harvard, 1926), Botanist; Dr. Glover M. Allen, Assistant Professor of Zoology, Zoologist; Mr. Harold J. Coolidge, Jr. (S. B. Harvard, 1927), Assistant Zoologist; and Mr. Loring Whitman (Harvard Medical School), Photographer and Assistant Ornithologist.

The following brief quotations will serve to emphasize the lack of knowledge regarding the interior of Liberia at the time the present expedition was made.

Maugham ("The Republic of Liberia," 1920) says: Liberia although normally only twelve days removed from the United Kingdom is nevertheless in all probability the one portion of West Africa of which today the least is known to us. Sir Harry Johnston (in the introductory chapter of his book "Liberia," 1906, which constitutes a compilation of our knowledge of this country) writes: "The interior of Liberia is still the least known part of Africa." — He also reiterates this opinion in several later chapters. Robert Durrant,[1] special Commissioner in West Africa, 1924, states that Americo-Liberian civilization has not extended inland, and that the settlers have not succeeded in penetrating into the interior for more than about thirty miles from the coast. He says further that "Liberia has escaped the notice of all the story tellers and of most of the chroniclers. The few books that have been written about it present such a wide divergence of opinion that the reader is forced to the conclusion that some of them at any rate were inspired." Sir Alfred Sharpe in "The Black Republic," 1923, writes: "In Monrovia there are few people who have been thirty miles inland. This applies not only to Liberians but to Europeans and is partly accounted for by the fact that under existing Liberian laws no one may go inland without a permit. Liberia is a rich country and is at present the one totally undeveloped stretch of West Africa."

---

[1] Durrant: Liberia, A Report published by the African International Corporation (1924), pp. 7, 34, 46.

No survey had yet been made of the diseases which afflict human beings, animals, or plants in the interior of Liberia, and the fauna and flora had not been fully investigated. Moreover, there was no record that any scientific medical expedition had been made into the interior of Liberia. But aside from our lack of medical and biological knowledge regarding the interior of Liberia there were several other reasons why it seemed advisable to the writer to conduct an expedition from the United States into that country.

First, Liberia is the only negro republic in Africa, and was founded in 1821 as an American colony at what is now the capital of the country, Monrovia. With the exception of Haiti, in which the United States has also been interested, it is the only negro republic in the world.

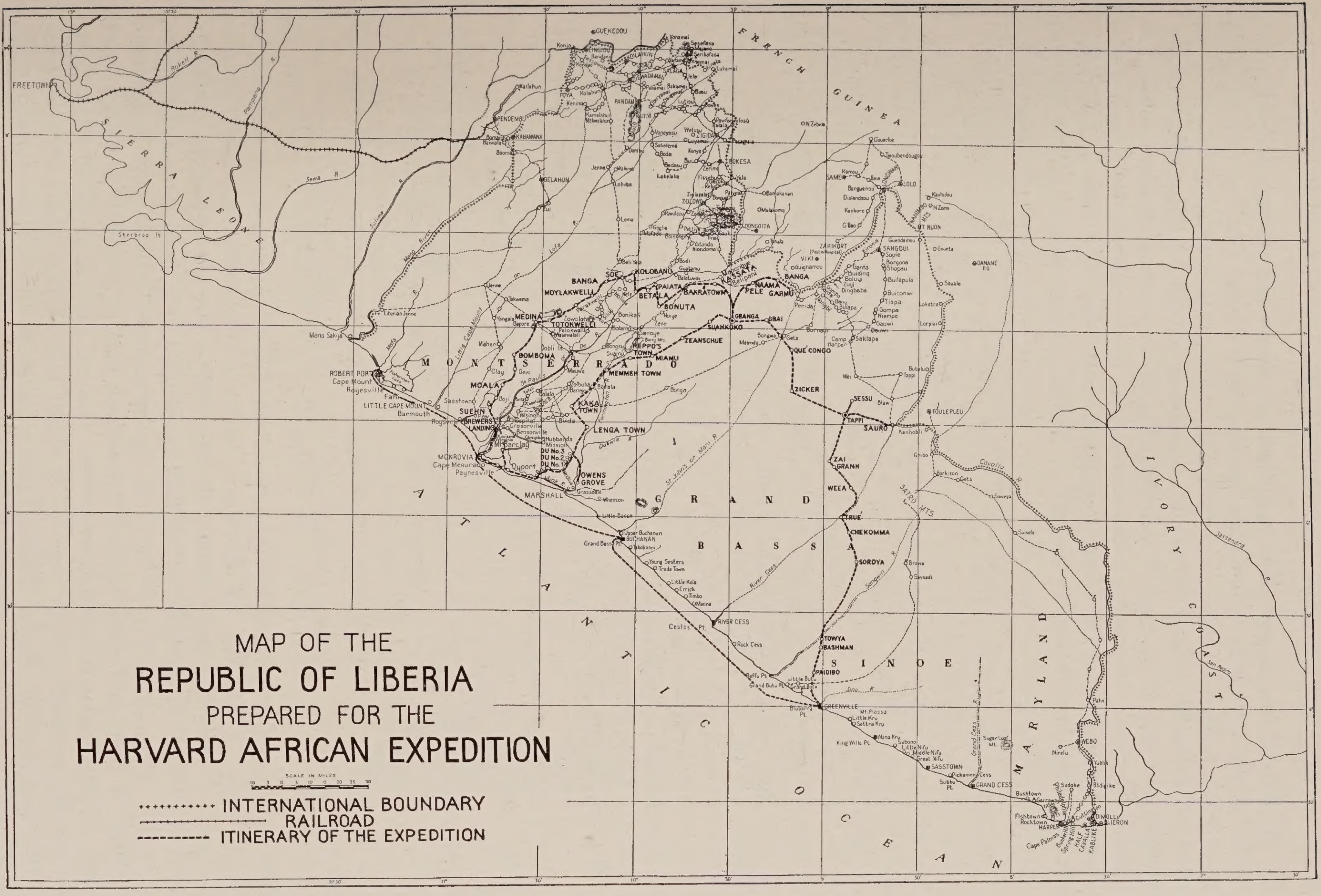
Second, since the Treaty of Versailles, the United States has been acting as the adviser in Liberian affairs, especially with reference to financial questions.

Third, Liberia may become an important source of supply of rubber to this country, for it is a great rubber-producing country, and Mr. Harvey S. Firestone of Akron, Ohio, has acquired a ninety-nine-year lease of a million acres of land there, upon which to raise rubber.

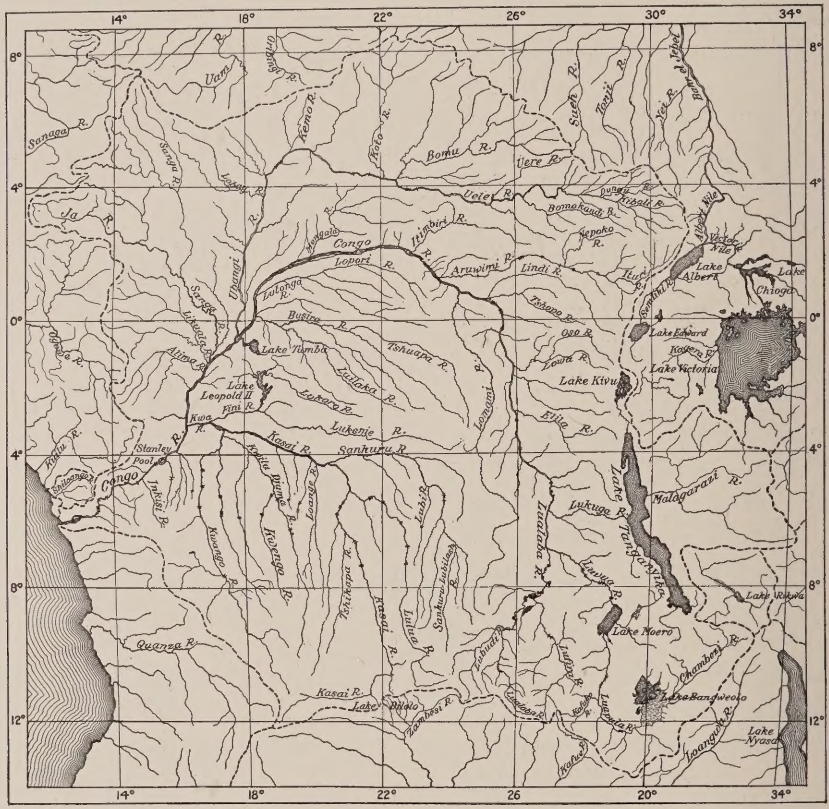
Fourth, the International Loan of 1912 has been refunded and replaced by a new loan from the Finance Corporation of America, with the National City Bank of New York acting as fiscal agent.

Our observations and studies were made both along the seacoast and in the interior of Liberia; the country was crossed in three directions, and investigations were carried out along the way, from base camps established at strategic points. Entering at Monrovia we travelled first to the northeastern part of the country, bordering upon French Guinea at Garmu and Banga, then to the eastern border at Sauro, touching the hinterland of the Ivory Coast, and thence southward to the coast at Sino (Greenville), and northwest to Cape Mount. Map II roughly illustrates the routes which we followed in the interior. It is perhaps superfluous to say that there is no trustworthy map of the hinterland of Liberia. The greater part of the country has not been accurately surveyed from a geographical standpoint, and most of the prominent features are inaccurately placed on the various maps obtainable. Those maps which are published illustrating the interior of the country are grossly inadequate and incorrect. The sources and courses of rivers, the heights of mountains, the situations and positions of towns are usually apparently hypothetical. We found that the names of the great majority of the towns and villages in the interior, inscribed on the published maps were unknown to the inhabitants of the regions concerned. The map of Liberia published in this Report has been prepared largely by some of the engineers of the Firestone Plantations Company and by members of this Expedition, particularly Dr. Shattuck, Mr. Whitman, and Dr. Bequaert. While obviously incorrect in many details since no geographical surveys were conducted in the central portions of the country, it gives a more nearly correct idea of the names and situations of the towns and villages in the interior than any other map available.

After the investigations had been completed in Liberia, the route travelled


MAP OF THE
REPUBLIC OF LIBERIA
PREPARED FOR THE
HARVARD AFRICAN EXPEDITION
SCALE IN MILES
INTERNATIONAL BOUNDARY
RAILROAD
ITINERARY OF THE EXPEDITION
FRENCH GUINEA
IVORY COAST
SIERRA LEONE
ATLANTIC OCEAN
MONTSERRADO
GRAND BASSA
SINOE
MARYLAND
FREETOWN
GUEKEDOU
ROBERT PORT
Cape Mount
LITTLE CAPE MOUNT
MONROVIA
Cape Mesurado
Paynesville
MARSHALL
BUCHANAN
Grand Bassa Pt.
RIVER CESS
Cestos Pt.
GREENVILLE
SASSTOWN
GRAND CESS
HARPER
Cape Palmas
BANGA
MOYLAKWELLI
MEDINA
TOTOKWELLI
BOMBOMA
MOALA
SUEHN
BREWERSVILLE
KOLOBANG
PAIATA
BETALA
BAKRATOWN
BONUTA
KAKATA
HEPPO'S TOWN
MIAMU
MEMMEH TOWN
LENGA TOWN
KAKA TOWN
OWENS GROVE
ZEANSCHUE
GBANGA
SUAHKOKO
GBAI
NAAMA
PELE
GARMU
QUE CONGO
ZICKER
SESSU
TAPPI
SAURO
ZAI
GRANH
WEEA
TRUE
CHEKOMMA
SORDYA
TOWYA
BASHMAN
PAIDIBO
TOULEPLEU
DANANE
SANGOUI
LOLO
KABAWANA
PENDEMBU
GELAHUN
BOKESA
ZIGIDA
PANDAMAI
KOLAHUN
SATRO MTS
NIMBA MTS
MT NUON
WEBO
Cavally R.
Sassandra R.
St. John's or Mani R.
Lofa R.
Mano River
Sewa R.
Sherbro Is.

Map No. II. — Routes followed in the interior of Liberia by the Expedition across Africa was through the Belgian Congo, following the course of the Congo River and the Lualaba to Kabalo. Studies were made in the various towns and villages in the regions of these rivers and elsewhere along the line of travel. From Kabalo we proceeded by rail to Albertville on Lake Tanganyika and from there travelled northeast on a small steamer across the lake to Kigoma. It may be remembered that it was in the adjoining town of Ujiji that Stanley met Dr. Livingstone on his first relief expedition in 1871. We next proceeded northward to Usumbura, Uvira and Luvungi, and from there on


14°
18°
22°
26°
30°
34°
8°
4°
0°
4°
8°
12°
Sanaga R.
Ja R.
Uam R.
Kemo R.
Koto R.
Bomu R.
Uere R.
Sueh R.
Tonj R.
Yei R.
Bahr el Jebel
Sanga R.
Lobay R.
Ubangi R.
Mongala R.
Congo
Lopori R.
Itimbiri R.
Uele R.
Dungu
Kibali R.
Bomokandi R.
Nepoko R.
Albert Nile
Victoria Nile
Lake Albert
Lake Chioga
Aruwimi R.
Lindi R.
Ituri R.
Semliki R.
Lake Edward
Kagera R.
Lake Victoria
Tshopo R.
Oso R.
Lowa R.
Lake Kivu
Lulonga R.
Busira R.
Lake Tumba
Tshuapa R.
Lomami R.
Likuala R.
Alima R.
Ogowe R.
Lake Leopold II
Fini R.
Kwa R.
Lukenie R.
Lokoro R.
Kasai R.
Sankuru R.
Stanley Pool
Congo
Kuilu R.
Inkisi R.
Kwango R.
Kwenge R.
Loange R.
Lubi R.
Tshikapa R.
Kasai R.
Lulua R.
Sankuru-Lubilash R.
Lualaba R.
Lukuga R.
Lake Tanganyika
Malagarasi R.
Elila R.
Luvua R.
Lake Moero
Lake Rukwa
Chambezi R.
Lake Bangweolo
Luapula R.
Lake Nyasa
Loangwa R.
Kafue R.
Zambesi R.
Kasai R.
Lake Dilolo
Lubudi R.
Lufira R.
Quanza R.
14°
18°
22°
26
20°
34°

Map No. III. — Hydrographic map of the Congo and adjacent territory traversed

foot to Bukavu on the southern shore of Lake Kivu. After crossing the lake in small boats to Kisenyi, we marched northward to Ruchuru. Here for the purpose of collecting and pursuing special studies, the party was divided into several groups. Eventually we reached the southern and eastern shores of Lake Edward. From Lake Edward we travelled northward by Kabasha, Luofa, and Lubero to Beni and entered the southwestern part of the Semliki Valley, and then, proceeding northward through the eastern part of the Ituri Forest, we eventually reached Irumu. In the Ruchuru and Ruindi plains, the Semliki Valley and the Ituri Forest a special study was made of the parasites that infect wild game as well as of the infectious diseases of man. Except that we used boats in crossing the lakes and went by motor the thirty miles from Uvira to near Luvungi, all our travelling in the Eastern Congo, as in Liberia, in all some 1500 miles, was done on foot, along trails and uncompleted roads.

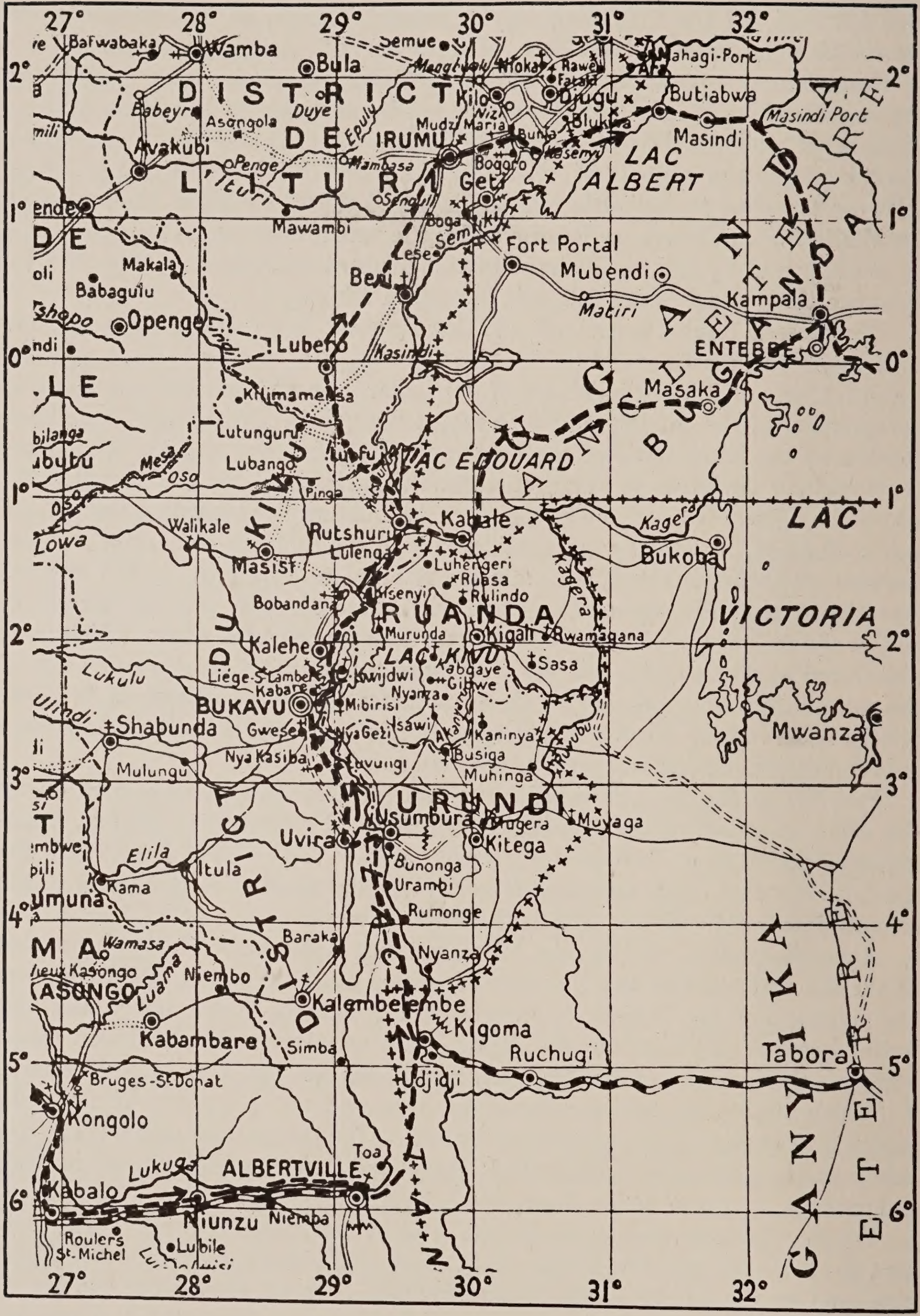
From Irumu we travelled by motor to Kasenyi on Lake Albert and after crossing this lake by steamer, we continued by Butiaba to Entebbe on Lake Victoria, at which place the League of Nations Sleeping Sickness Commission was pursuing its investigations, with Dr. Lyndhurst Duke as chairman. From there we travelled to Kampala and to Jinja and the Ripon Falls, the source of the White Nile. Thence we journeyed by the usual route across Lake Victoria by steamer and by rail via Nairobi to the coast at Mombassa. Maps IV–VI illustrate the general routes followed in eastern Africa.

The present Report is divided into three parts. In the first, an attempt has been made to describe very briefly the more important geographical and climatic features of Liberia which are of particular interest in connection with the development of the country and with travel through it. Next, there have been considered the inhabitants of the coast and of the interior and the special aspects of their government, tribal customs, industries, and the conditions under which the natives live. Some of the more general features regarding the botany and zoology of the country are considered, and the sanitary conditions and the diseases which affect the inhabitants are referred to. In Part II, the original investigations carried on in connection with these diseases are next described, and in the following chapter the infectious diseases of useful plants which were discovered are dealt with. Finally a study of the parasites of wild game and of the relationship of a number of these parasites to human disease is detailed. Special observations made in the Belgian Congo are included, and a comparison between conditions in the two countries is made.

Part III of the Report includes the biological investigations carried on by the other members of the Expedition with special reference to botany, mammalogy, ornithology, herpetology, helminthology, and entomology, and the special reports of other scientists who have kindly studied certain parts of the scientific material collected during the Expedition.

Acknowledgments. It has been intimated that it was particularly on account of the friendly interest that the United States has maintained in Liberia, and the activities of Mr. Harvey S. Firestone in developing that country, that the writer became interested in investigating the conditions that prevailed there. Through the kindness of Mr. Firestone and of his son, Mr. Harvey S. Firestone, Jr., much hospitality and great assistance was rendered us in Monrovia and the vicinity. For these many courtesies, as well as for the interest which they have taken in the scientific investigations completed in this country, and in their publication, we again desire to express our gratitude.

We are particularly grateful for the interest and support to our work which was given by the late Dr. Frederick C. Shattuck, Emeritus Professor of Medicine, and by the late Professor Charles Sprague Sargent, Director of the Arnold Arboretum. In addition we are especially indebted to President A. Lawrence Lowell and Dean David L. Edsall, for their interest and assistance in the organization of the Expedition.


27°
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Bafwabaka
Wamba
Bula
Semue
Mahagi-Port
Aru
DISTRICT DE L'ITURI
Babeyru
Asongola
Duye
Avakubi
Penge
Ituri
Epulu
Mambasa
IRUMU
Kilo
Niziz
Mudzi Maria
Nioka
Fataki
Djugu
Blukwa
Bunia
Kasenyi
Bogoro
Geti
Butiabwa
Masindi
Masindi Port
LAC ALBERT
Mawambi
Boga
Semliki
Lese
Beni
Fort Portal
Mubendi
Matiri
Kampala
ENTEBBE
Makala
Babagulu
Opengo
Lubero
Kasindi
Kilimamensa
Lutunguru
Lubango
Rutshuru
Pinga
LAC EDOUARD
Masaka
OUGANDA
Walikale
Masisi
Lulenga
Kabale
Luhengeri
Ruasa
Rulindo
Kisenyi
Bobandana
Kagera
Kagera
Bukoba
LAC VICTORIA
RUANDA
Murunda
Kigali
Rwamagana
Kalehe
LAC KIVU
Kabgaye
Gitwe
Sasa
Liège-St Lambert
Kabare
Kwijdwi
Nyanza
BUKAVU
Mibirisi
Shabunda
Gwese
NyaGezi
Isawi
Akanyaru
Kaninya
Mwanza
Nya Kasiba
Luvungi
Busiga
Muhinga
Mulungu
URUNDI
Usumbura
Gitega
Kitega
Muyaga
Uvira
Bunonga
Urambi
Elila
Itula
Kama
DISTRICT DU KIVU
Rumonge
Baraka
Nyanza
Wamasa
Kasongo
Niembo
Luama
KASONGO
Kalembelembe
Kigoma
Ruchugi
Kabambare
Simba
Ujiji
Tabora
Bruges-St-Donat
Kongolo
Toa
ALBERTVILLE
Lukuga
Kabalo
Niunzu
Niemba
Roulers St-Michel
Lubile
LAC TANGANIKA
TERRITOIRE DU TANGANYKA

Map No. IV. — Routes followed in Eastern Belgian Congo from Albertville to Entebbe

For the opportunities granted us for travel and investigation, we also desire to express our appreciation to the following gentlemen through whose courtesy and assistance our work was greatly facilitated.

To Secretary of State Frank B. Kellogg and Assistant Secretary of State William R. Castle, Jr.; the American Ambassador to Great Britain, Alanson B. Houghton; and the American Ambassador to Belgium, William Phillips, — for diplomatic courtesies and arrangements with relation to the itinerary of the Expedition in Liberia, Belgian and British territory.

To President Charles Dunbar Burgess King, Secretary of State Edwin S. Barclay, and the other members of the Cabinet of Liberia, — for many courtesies and much governmental assistance, without which many of our investigations in Liberia would have been impracticable.

To the Honorable Reed Paige Clark, Chargé d'Affaires, American Legation, for many courtesies, and for much valuable information and assistance furnished throughout our stay in Monrovia; also to Mr. Clifford R. Wharton, Secretary of the American Legation at Monrovia, for many courtesies.

To Mr. Donald A. Ross, General Manager of the Firestone Plantations Company; Mr. William D. Hines, special representative of Mr. Firestone; Dr. G. Bouet, French Consul to Liberia; Mr. Max Dinklage, German Consul to Liberia, Dr. Paul T. Willis of the Firestone Plantations Company; Bishop Campbell and Mr. Plenyono Wolo of Monrovia; and Messrs. Donovan and Webster of the American Church Mission at Cape Mount, — for courtesies and advice or assistance in Liberia.

To Premier Ministre Jaspar of Belgium; M.-N. Arnold, Administrateur des Colonies; and M.-E. Leplae, — for diplomatic courtesies and exceptional opportunities granted, and for arrangements made to facilitate our travel throughout the Belgian Congo.

To Dr. J. Derscheid of the Congo Museum in Brussels, — for courtesies extended in connection with the Museum, and assistance given in the Belgian Congo in the region of the Kivu volcanoes; Drs. J. Rodhain and A. Broden, of the School of Tropical Medicine, Brussels, for much advice in connection with our work in the Belgian Congo.

To His Excellency Governor-General M. Rutten of the Belgian Congo; Commissaire General Beernaert, Acting Vice-Governor at Leopoldville; Governor Moeller of the Province Orientale at Stanleyville; Governor C. Duchesne at Coquilhatville; Director Corbisier of the Botanical Gardens at Eala; and Dr. R. Mouchet, Chief of the Medical Staff of the Belgian Congo at Boma, — for courtesies and special facilities and assistance in the Belgian Congo.

To Professor F. Van den Branden, Director of the Laboratory at Leopoldville; Dr. A. Duren, Chief of the Hygienic Service for the Province of Congo-Kasai, Kinshasa; Dr. LeDentu, Director of the French Pasteur Institute at Brazzaville; Dr. Strada at the Native Hospital at Coquilhatville; Dr. P. Stoner, Botanical Garden, Coquilhatville; Dr. Indorff at Alberta; Dr. Feys at Lisala; Dr. Clement C. Chesterman and Dr. K. Waller Todd at Yakusu; Dr. L. Fornara, Head of the Medical Staff and Doctors Donadio and Clevers at Stanleyville; Dr. Devos at Bukavu; Dr. Delafosse at Beni, and Dr. H. Lyndhurst Duke, Chairman of the Sleeping Sickness Commission at Entebbe, Uganda, — for hospitality and assistance in our medical investigations.

To Mr. Robert N. Kennedy, Director of L. C. Gillespie & Sons in Kinshasa, for many courtesies and great assistance in Kinshasa; Manager Anruhn for courtesies at the Lever Brothers Oil Plantations at Alberta; Administrateur Daniels of the Belgian General Service in Beni, for assistance in connection with transportation; Captain Jeffrey Catchpole of Bunia, for much advice and assistance in hunting wild game and in performing autopsies upon wild animals; and to the White Fathers, for courtesies at Nyagezi, Lulenga, and Beni.

To Sir Alfred Sharpe of London; Lord Leverhulme; Mr. Robert Williams of the Union Minière; C. W. Dresselhuys, Liberian Minister of London; and Mr. Leslie Cooper, General Manager of the Bank of British West Africa, — for courtesies and advice which facilitated our work in Africa.

We wish also to express our indebtedness to Mr. L. C. Gillespie of New York, and to thank him for letters of introduction to the agents of L. C. Gillespie and Sons in the Belgian Congo; Mr. Edward Mallinckrodt, President of the Mallinckrodt Chemical Works of St. Louis, for a quantity of chemical and photographic supplies; Messrs. Hynson, Westcott, and Dunning, for antimonial preparations; Merck and Company of Philadelphia, for supplies of tryparsamide; the A. H. Metz Laboratories, Inc., of New York, for ampules of sodium thiosulphate; the Winthrop Chemical Company of New York, for "Bayer 205"; and Messrs. Poulenc Frères of Paris, for a supply of "Fourneau 309." We also wish to thank Dr. A. Hamilton Rice, Vice-President of the American Geographical Society, Organizer and Director of its School of Geographical Surveying, and Mr. Weld Arnold, Fellow, American Geographical Society, for assistance in the preparation of African maps; Professor Oakes Ames for assistance in determination of the species of orchids; and Mr. Hill at Kew for assistance in determining a portion of the flowering plants collected.

I wish also to take this opportunity to express again my great appreciation to the other members of the Expedition for the very efficient work they have carried on, and for their entire cooperation and assistance throughout the Expedition.

I am also grateful to the other collaborators in Part III of this Report, Dr. J. H. Sandground, Dr. N. A. Cobb, Dr. Thomas Barbour, Mr. A. Loveridge, Dr. Herbert Friedmann, Dr. C. T. Brues, Dr. C. P. Alexander, Dr. G. F. Ferris, Dr. Philip P. Calvert, and Mr. Nathan Banks, for their interest and the assistance they have rendered, through their scientific contributions upon the material collected.

Finally, I wish to thank Miss Catherine M. Casassa, Secretary of the Department of Tropical Medicine, for great assistance in connection with the preparation of the manuscript and for the preparation of the index.

I am particularly grateful to Mr. Loring Whitman, the photographer of the Expedition, who took most of the pictures herein reproduced. The majority of the photographs referred to in the botanical section were taken by Dr. David

H. Linder; a few others were taken by Dr. G. C. Shattuck, Mr. Harold J. Coolidge, Jr., Dr. Glover M. Allen, Mr. Dinklage, and myself.

The excellent microscopical drawings have been made by Mrs. Etta Piotti Ramsdell, and the photomicrographs by Dr. Henry Pinkerton and Mr. Ernest E. Fewkes.

Since the return of this Expedition to the United States, considerable attention has been attracted to the African Republic of Liberia from several different standpoints. The unsanitary conditions which have prevailed in Monrovia and the vicinity, particularly with reference to the occurrence during the past year of malaria and yellow fever in American and European citizens (which are referred to in Chapters XIV and XVI of this Report), have led to steps being taken in the United States to improve these unfavorable conditions.

Also, there has been much publicity and interest taken, in connection with the opportunities offered by Mr. Firestone, for the development of the country and for the welfare of its people.

In addition, the terms of the new loan to Liberia have given our State Department further opportunity to demonstrate the friendly American interest in the welfare of both the Americo-Liberian people and the indigenous inhabitants.

Moreover, the League of Nations has very recently interested itself in certain conditions that exist in the country, and since the pages of this Report have begun to pass through the press, an International Commission has been appointed by the League to investigate in Liberia certain conditions regarding enforced labor and slavery among the indigenous inhabitants. The conditions under which these people live in the interior of Liberia are described particularly in Chapters IV to IX.

It is trusted that these and other activities related elsewhere in the present Report, and the medical and biological knowledge recorded herein, will lead to a new era of prosperity in the development of the country and the welfare of its people as a whole.

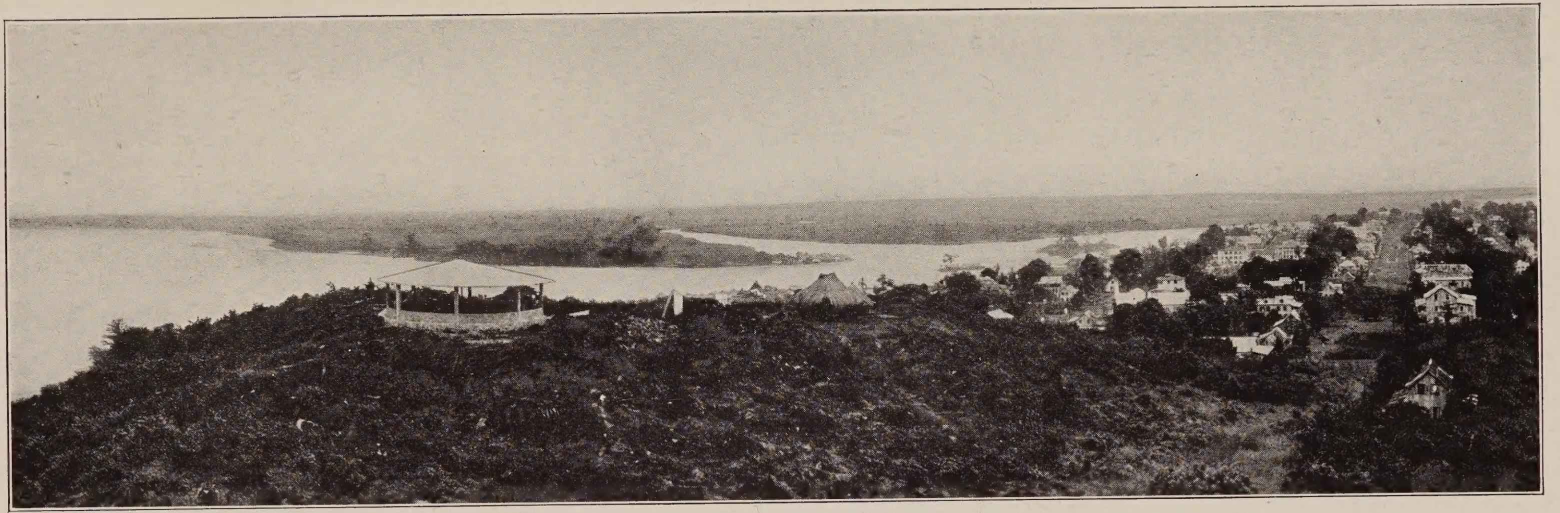
II

GEOGRAPHY

Liberia, with an area usually estimated at from 42,000 to 43,000 square miles, lies on the west coast of Africa, approximately between 4° 22′ to 8° 50′ north latitude, and 7° 33′ to 11° 32′ longitude west of Greenwich. It is bounded on the west by the British Colony of Sierra Leone, on the north and east by French Guinea and the Ivory Coast, and on the south by the Atlantic Ocean.

The general trend of the coast line is from northwest to southeast, so that it is nearly parallel to the course taken by steamers plying between Europe and West and South Africa. The country has a coast line of about 350 miles which is little indented, and which possesses no natural harbors or points of sheltered anchorage; and the mouths of all rivers are closed to steamers by sand bars. The coast is in general low and monotonous and more or less broken up by lagoons and tidal creeks. Its monotony, however, is relieved as you travel south from the northern boundary by several capes and promontories which especially attract attention. Of these, Cape Mount with an altitude of 1,068 feet above the sea is by far the most striking. The next promontory of importance is Cape Mesurado, on the northwestern face of which the town of Monrovia is built. The headland, however, consists of hardly more than a series of cliffs from one hundred and forty to three hundred feet above sea level. Although there is no harbor, the shelter from the southeast formed by Cape Mesurado makes it safe for large vessels to anchor on the sandy bottom. In landing from steamers one must pass from such an anchorage in surf boats manned by Kru oarsmen, across the sand bar into the quiet waters of the Mesurado Lagoon. Still further southward, but to the east of the Sangwin River, is another promontory known as Baffu Point; and a fourth promontory is at Cape Palmas, near the southern boundary of the country.

The coast and hinterland from just above Cape Mount and below Cape Palmas are divided into four unequal sections by four of the largest rivers which flow into the ocean. These are the Mano, St. Paul, St. John, and Cavalla. The Mano, after passing through thick forest country in the interior gains the sea a short distance above Cape Mount. The Mano River is virtually valueless as a navigable waterway, for it is usable only by small boats and canoes for a short distance from the sea. However, it is of geographical importance since through part of its course it forms the western boundary of the Republic. Travelling southeastwardly along the coast one next reaches a small stream some thirty-five miles in length, known as the Mafa River which is also shallow and not navigable for any distance from the sea. It discharges its waters partly into a large lagoon known as Fisherman's Lake, and partly into the ocean. In addition it gives rise to a long creek that runs parallel with the coast, and that is sometimes called the



No. 1. — Monrovia. The point of anchorage for ocean steamers is located at the left edge of the photograph. The shallow entrance over the sand bar into the Mesurado Lagoon is distinguishable, as well as its junction with Stockton's Creek. The greater portion of the city (particularly the residential section) is also visible in the right third of the photograph

Shuguri River. Fisherman's Lake is a large sheet of brackish water, subject to the influence of the tides, and in places surrounded by mangrove swamps. Several small streams enter it from the northeast. It is about ten miles long and from three to four miles wide, with an approximate depth of from five to fifteen feet. The entrance both to the Mafa River and the outlet of Fisherman's Lake is just to the north of the promontory of Cape Mount. At low tide there are but three feet of water on the bar, a fact which unfortunately precludes the construction of a useful harbor behind Cape Mount in what is perhaps the most attractive situation on the coast. Cape Mount itself is surrounded on three sides by the ocean and by its situation and superior altitude above the sea, is exposed to much cooler breezes than the surrounding coast land and consequently is a more favorable position for a residence. On both sides of the promontory, the shore is low and marshy.

At the foot of the northwestern side the Liberian town of Robertport is situated and on the higher ground near the summit of the headland, a small village has been built, near which is the Episcopal Mission with its separate schools for boys and girls.

On the coast for several miles round, is a succession of small settlements, the most important of which are Royesville and Fahi, and which are occupied for the most part either by members of the Vai tribe or by Americo-Liberians.

East of Cape Mount the coast is low and even swampy. The little Cape Mount River, sometimes called the Lofa, flows into the ocean about halfway between Cape Mount and the next cape, Mesurado. In its lower course it runs through the Po range of hills. Its course in the interior is not known, but the suggestion has been made that it forms the lower part of that river further north which is given on some maps as the Lofa, and said to rise in the Mandingo Plateau.

A short distance from the mouth of the Little Cape Mount River is a stream called by some of the inhabitants the Poba River, near which another Vai settlement named Roysville[1] is situated.

A few miles farther to the eastward, one reaches the mouth of the St. Paul River, one of the largest in Liberia, the upper part of which is known as the De (Illustration No. 434). Possibly a river referred to by French explorers as the Diani and said to rise in the French Sudan may also form a remote part of the St. Paul or perhaps one of its tributaries. The length of the St. Paul has been given by Johnston[2] as two hundred and eighty miles, on the assumption that its source is that of the Diani in the Mandingo Plateau. However, neither the source of the St. Paul nor its actual course has been accurately charted. As will be seen from Map II, the members of the Expedition were frequently in its vicinity and in that of its tributaries.

We have referred to the fact that the mouth of the St. Paul is closed for ocean steamers by a wide and dangerous sand bar at its mouth. There is, however, a narrow tidal channel known as Stockton's Creek, which connects the lower

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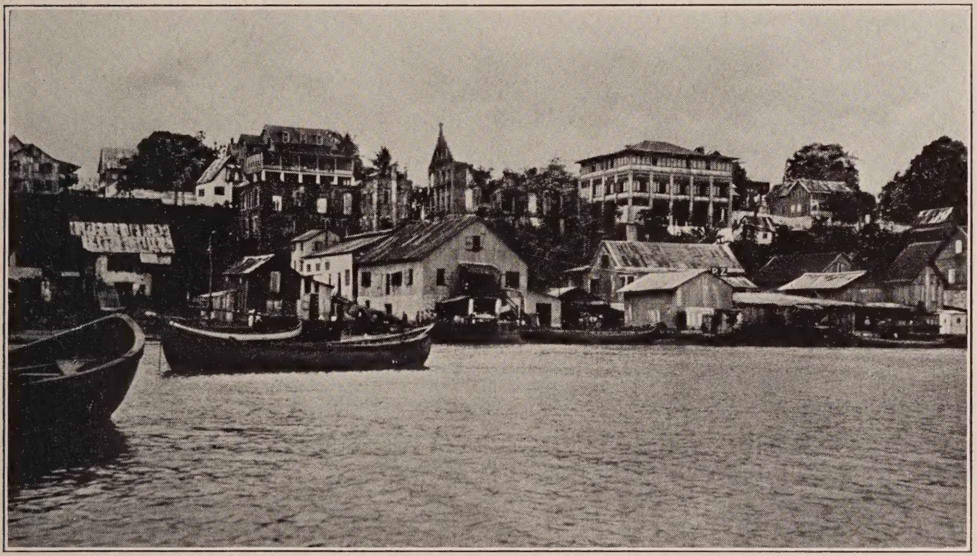
[1] The name of this town is apparently generally spelled differently from the more northward Royesville.

[2] Sir Harry Johnston: "Liberia" (1906), I, 438.

St. Paul near its mouth with the Mesurado Lagoon at Monrovia. At low tide Stockton's Creek has a depth of merely two or three feet, so that only vessels of very light draught can navigate it.

Monrovia is situated about four miles to the southeast of the mouth of the St. Paul River. Its anchorage for ocean steamers, already referred to, is at least three-quarters of a mile from the shore. In landing, passengers and goods from the steamers must be carried through the surf, which is often high, in boats propelled by native oarsmen, into the Mesurado Lagoon beyond the sand bar. From here they can be transported in such surf boats or in small steam launches along Stockton's Creek into the main branch of the St. Paul, and up this river for a distance of about eighteen miles from the sea to the village of White Plains.



No. 2. — Monrovia, the lower portion of the city from the Lagoon

Just above White Plains are encountered the first rapids on ascending the river from the ocean. These rapids occur for some hundred miles up the river, which, in stretches, is then again navigable for canoes.

It is just above White Plains, some seventeen miles from the coast, that the hospital of the Lutheran Mission has been constructed. The only hospital in the hinterland of Liberia is that of the Holy Cross Mission, situated near Kenima at Masambolahun, about fifteen miles from the northwestern border of Liberia and thirty-eight miles from the head of the Sierra Leone Railway at Pendembu.[1]

What may be called the residential section of Monrovia is the top of the plateau of Cape Mesurado, the highest point of which is about three hundred feet above sea level. At the extremity of this narrow plateau or ridge is a precipitous cliff, at the base of which the ocean surf beats. On the highest point of this cliff, known as Mamba Point, a lighthouse is erected and the remains of an old fort are visible.

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[1] These distances are computed from the Map of the War College, Division General Staff, Washington, 1916.

What may be called the business section of Monrovia lies along the "Waterfront," a narrow strip of land which extends both along the coast near the foot of Mamba Point and along the shores of the Mesurado Lagoon. This Lagoon constitutes then the real harbor of Monrovia. On the Monrovian side it is lined with wharves where lighters and surf boats and a few steam launches are moored.

The Lagoon communicates with the ocean between two sand bars opposite Bushrod Island which faces the sea on the west and which has Stockton's Creek on the other three sides.

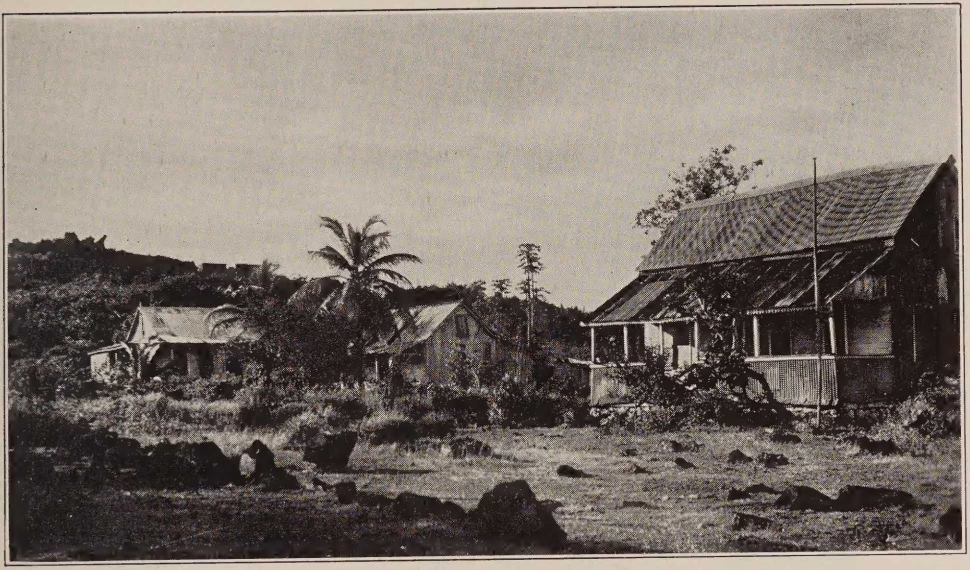
On the north side of the Mesurado Lagoon, between Stockton's Creek and New Georgia Creek, is a large swampy area known as Bali Island. Just to the northeast of Monrovia is a long winding tidal creek known as the Junk River. The Mesurado Lagoon extends its tidal creeks to within a short distance of the most westerly creek of the Junk River. But for this narrow isthmus between the town of Paynesville and the westmost branch of the Junk River which reaches to Duport, the land on which Monrovia is built would form part of a long island about thirty miles in length and averaging some three miles in width, surrounded by the Junk and Mesurado rivers and the sea.

The Junk River flows almost parallel with the coast for about fifteen miles. Its eastern reach constitutes the estuary of two rivers, the Du, or Dukwia, and the Farmington, which enter it near its mouth. At Marshall, at the mouth of the Junk river, where it empties into the sea, there is a very bad bar which in itself would prevent the town from becoming an important port. This river is very shallow in places; in the neighborhood of Duport, it is only two to three feet in depth at certain seasons of the year. On this part of it we were able to travel only in canoes. However, where it joins with the Dukwia it becomes considerably deeper.

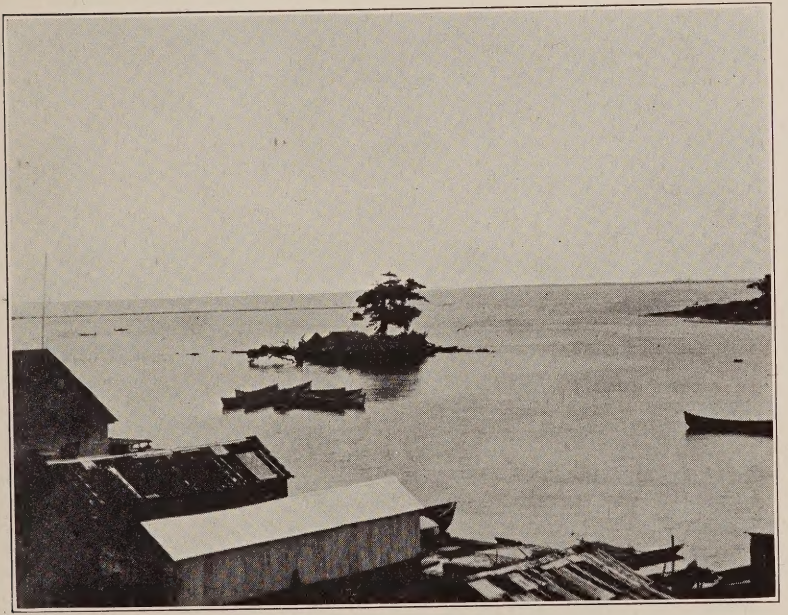
The Dukwia is a more important river than the Junk, since it is navigable for surf boats and steam launches of light draught for about thirty miles from the sea to the point where its first rapids occur. It is very winding but until entering the Junk River its general course is southwest. Like practically all of the rivers in the interior, it flows in places through dense forest. The Expedition travelled up this river in a launch as far as it was navigable. Its upper course is still unknown. It is along the lower reaches of this river and to the west of it, in the vicinity of Mt. Barclay, that many of the most important rubber plantations in Liberia are at present situated.

Whereas the Junk flows east and southeast, the Farmington River, except at its mouth, follows in general a southwesterly course. Just above the village of Owens Grove, some eight miles from the coast, occur the first rapids. Some of its tributaries were traced in the interior as far as Gbanga.

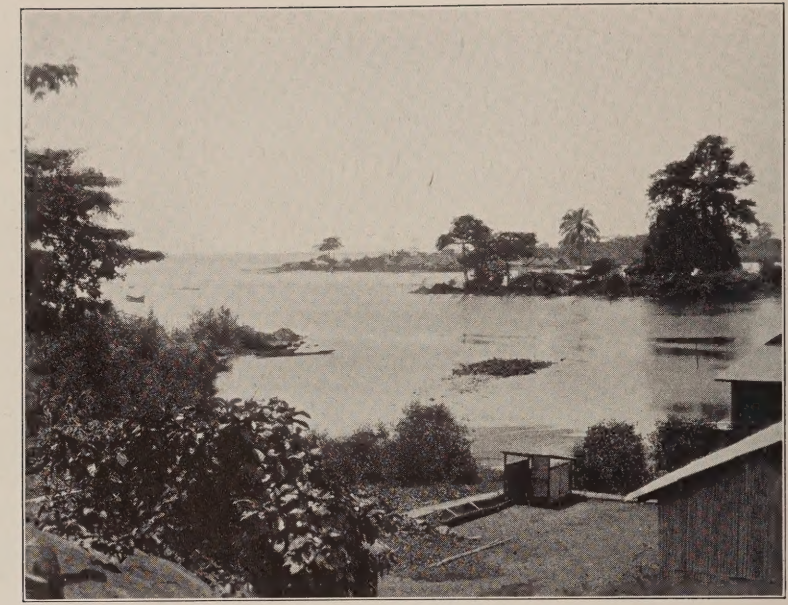
The region between the St. Paul and the Dukwia and Farmington rivers is the most densely populated part of Liberia, and the areas between Careysburg and the coast are occupied particularly by the Americo-Liberian population.



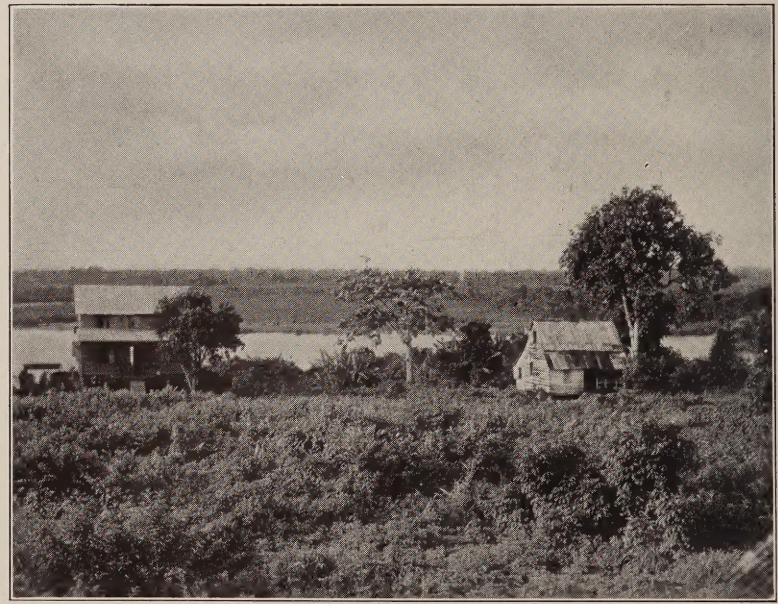
No. 3. — Highest point of Cape Mesurado



No. 4. — Sand bar and entrance to Mesurado Lagoon

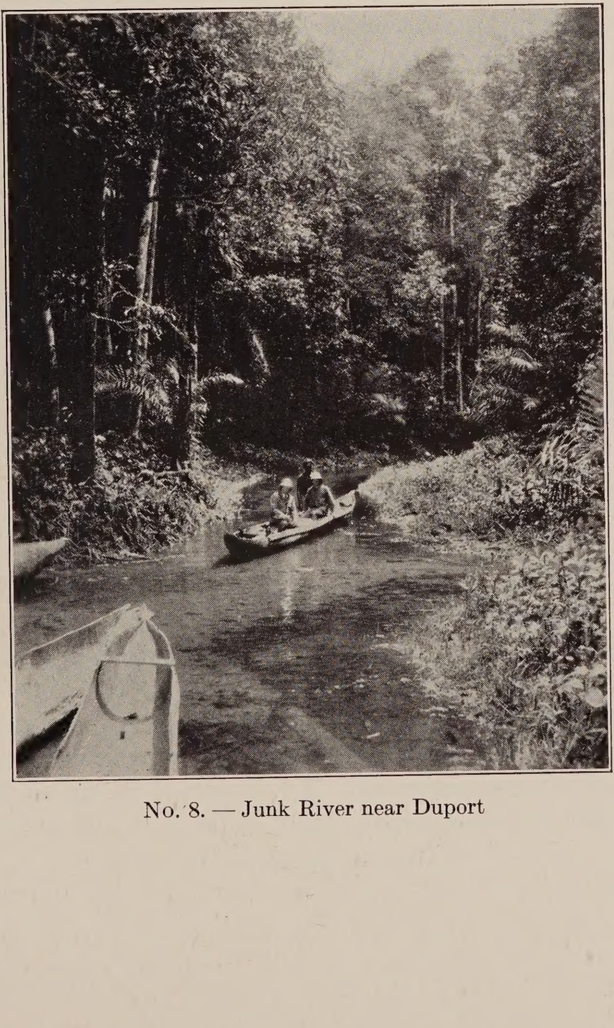


No. 5. — Entrance from the ocean into Stockton's Creek



No. 6. — Portion of the Lagoon above Monrovia

No. 7. — View from Mamba Point, Monrovia



No. 8. — Junk River near Duport

The lagoons and tidal creeks which have been described, the marshes, particularly about Monrovia and its vicinity, and the decaying vegetation in and about them, have an important bearing on the sanitary condition of these places and particularly on insect-borne diseases and their prevention.

Travelling along the coast southward, the next important river is the St. John, which enters the sea near the village of Grand Bassa. The source and the course of this river also have not been accurately determined. However, the St. John is known to flow in general in a southwesterly direction through approximately the center of Liberia. The Expedition crossed it or its tributaries on several occasions, the most northerly point being close to the border of Liberia and French Guinea near the town of Banga. During much of its course it flows through forests. We found no boats on this river in the interior, and were compelled to cross it on rafts constructed of freshly hewn forest trees. Near its mouth, on the coast, are the villages of Buchanan and Upper Buchanan. Just before it flows into the sea its mouth widens and there are several small islands where the Benson Creek on the left and the Mechelin on the right enter it.

The bay formed by MacDonald Point, beyond which the St. John enters the ocean, and the Grand Bassa Point some few miles to the southeast, is studded with dangerous reefs. On account of the high surf and river current, landing at the mouth of the St. John is more or less difficult at any time of the year, and especially so in the rainy season when the breakers are exceptionally high and perilous. The promontory of Grand Bassa and the reefs in the vicinity to some extent, protect the anchorage in this bay. We were compelled to land at Grand Bassa through the surf where the waves were at the time much lower than in the vicinity of the mouth of the St. John River.

The next important river to empty upon the coast, as you travel southward, is the River Cess. It was located by us as far inland as Sauro on the eastern border of Liberia and the hinterland of the French Ivory Coast. Johnston[1] says it probably rises in the Satro Mountains. However, according to the available maps, the Satro Mountains are situated some thirty or forty miles either south or southwest of Sauro. The Expedition crossed this river in the dense Bassa Forest at the village of Trué, some fifty miles from the coast. The mouth of the river is closed at the sea by a bar and by ledges of rocks over which, at ebb tide, the water is only three or four feet deep.

The coast southward is still more rocky and the entrance to the Sangwin River, the next large tributary, is beset with rocks and reefs, which make passing through its mouth a dangerous procedure unless one is familiar with the place. There is, however, at the south, a fairly clear channel over a bar which is said to have from eight to ten feet of water at ebb tide. To the east of the mouth of the Sangwin River is the promontory of Baffu Point, already referred to, with a small bay beyond it. We travelled parallel to this river for some distance in its course through the forest in the interior, and crossed many of its small tributaries or entering streams. We crossed it in canoes for the last time at the village of Towya, some twenty-eight miles from the seacoast.

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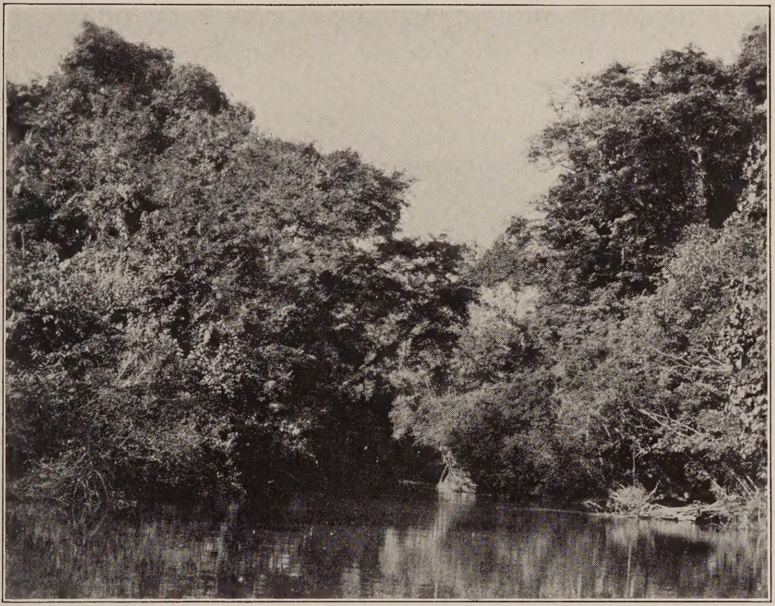
[1] Johnston: *Loc. cit.*, p. 462.



No. 9. — Du River near its junction with the Junk

No. 10. — St. John River in the interior and to the east of Gbanga

The next important river entering the sea is the Sino, the mouth of which is at the town of Greenville or Sino. Of the entrance to the mouth of this river, Johnston states that to those who are greedy of sensational experience, he would recommend landing at a time of the tide and of the year when the surf is bad.

> Leaving the steamer at a distance of about three-quarters of a mile off Blubarra Point, they will be rowed over the lumpy waves for a distance of a mile before the actual danger commences. To avoid the worst of the rollers they will have to pass very close to the Savage Rocks on North Point, rocks which above and below water exhibit sharp fangs on which, with the slightest contact, a boat would be instantly impaled. To the west and north are great sand banks on which the breakers are foaming angrily, and chains of rocks or rocky islands. As the extremity of North Point is reached, the boat, propelled with all the vigor of Kru boy arms, and with all the way on her, is suddenly arrested by the force of the tremendous current of the Sino River which pours violently as from some cataract round North Point into the sea. If the tide is at the ebb it is well nigh impossible to withstand the force of this current, which is striving to dash the boat on the Savage Rocks or fling it on the sand bank where the surf would break it to pieces. But the Kru boys usually know their danger and they have become used and callous, and though the boat may remain stationary for half an hour while the boys strain their muscles to keep it from gliding backwards on to the rocks or the shallows, it usually begins at length to move forward by inches and then by feet until North Point is rounded and the boat makes its way into the relatively tranquil stream of the clear river and to the town of Greenville.

It is perhaps necessary to enter or leave the mouth of the Sino to appreciate the difficulties of the passage. It was from this point that part of the Expedition travelled in surf boats up the coast of Liberia to Monrovia. The river can be navigated by canoes for about fifteen miles up stream. Usually, however, navigation even in canoes is difficult for more than ten or twelve miles of its course. A creek, starting from the eastern bank of the river near its mouth, runs parallel with the coast at a distance of from two to three miles from the sea.

The Grand Cess River, which is the next one encountered in travelling south, enters the sea through a very narrow opening at the village of Grand Cess. Apparently the most important point about it is that near the coast it forms the geographical boundary between the so-called provinces of Sino and Maryland. We did not visit this river.

The last river of any importance to reach the Liberian coast is the Cavalla. It marks the southern boundary of Liberia and flows between it and the Ivory Coast. Probably the longest stream in Liberia, it is the most important in size, since it is navigable for small vessels for sixty to eighty miles, from the point a few miles eastward from Cape Palmas where it empties over a dangerous bar into the sea. Owing to the bar, the village of Harper, several miles away, has been found a more suitable point than the mouth of the river for disembarking passengers and goods destined for this part of the country. At Harper a salt lagoon, known as Shepherd Lake, affords a means of transport by canoes for goods intended for settlements on the river. At the present time the French have complete control over this stream. It does not enter Liberian territory.

Reference has been made to the fact that with the exception of the few promontories already referred to, the coast of Liberia is low and only broken here and there by the mouths of the rivers and by numerous tidal creeks and lagoons. More or less low land with swampy areas prevails round all the villages and

No. 11. — Coast of Grand Bassa, near the mouth of the St. John River

No. 12. — Sangwin River (interior) above Towya

towns situated on the coast. In the majority of places the land has been more or less cleared of virgin forest from the towns and villages, and secondary vegetation rules. Near a few of the rivers and in the more inaccessible parts of the country large areas of forest and jungle still exist.

At a distance of from twenty to thirty miles inland, in different places, the dense forests usually are found which cover the greater part of the hinterland of Liberia, except for the clearings, in which the various villages and farms or plantations are situated. Only in the extreme north and particularly in the vicinity of the Mandingo Plateau is there anything resembling park-like country. Johnston,[1] emphasizing the fact that Liberia is still the least known part of Africa, says that nowhere else are the forests so thick and luxuriant and so unsubdued by man, perhaps not even in the most eastern parts of the Congo Free State. Through some of the Liberian forests there is practically no travel of any kind. The botanical features of these forested regions and the conditions in the villages of the interior will be referred to later in this Report.

As one travels into the interior of the country foothills begin to appear after a few miles. In fact, the land is nearly everywhere more or less hilly and in parts there are low mountains. The height of the highest of these, however, has obviously been greatly exaggerated.[2] The surface generally rises from the coast through a series of low broken ridges and rolling hills, among which are numerous narrow, shallow valleys. To illustrate the increasing altitude from the coast through the interior, it may be stated that at Reppo's Town (see Map II) the altitude is already about 350 feet, and that at the village of Miamu, it is 860 feet. At Zeanschue it drops temporarily to 720 feet, and at Suahkoko (eighty miles from the coast) it is again 870 feet. At Paiata (eighty-five miles from the coast on the St. John River,) the altitude is 740 feet. Near Bakratown it is approximately 1500 feet, and in places in the vicinity of Garmu it reaches in the neighborhood of 1800 feet. In the northeastern part of the country these hills terminate in the broad Mandingo Plateau already referred to, with an altitude of some 2500 feet. At the foot of most of the hills is a stream along which there is frequently a swamp or marsh. In travelling in the interior of Liberia, particularly in its central and eastern regions, one is almost continually either ascending or descending these low hills between which streams flow. In a single day's march, one may cross from forty to fifty low hills and ridges. The streams and brooks between the small villages are hence very numerous. However, there are no very extensive marshes or large fresh-water lakes in the interior. As the streams are fed by the heavy rainfall, there is nowhere in the country any dearth of water, but everywhere a great abundance of it, and it is usually limpid and potable. The clear-running streams in which there is an abundance of cool water are in the greatest contrast with what one finds, for example, in the eastern and central Congo regions, where one very rarely encounters clear water but usually only mud-colored water which it is often

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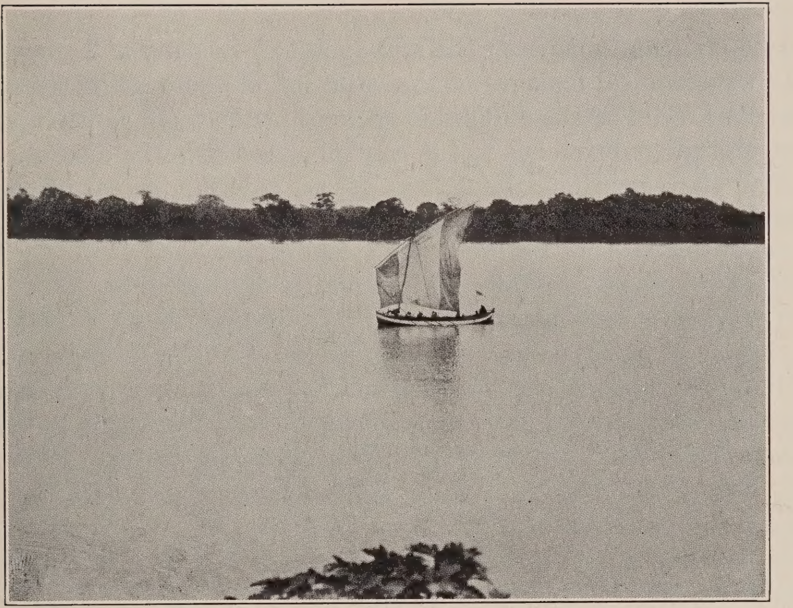
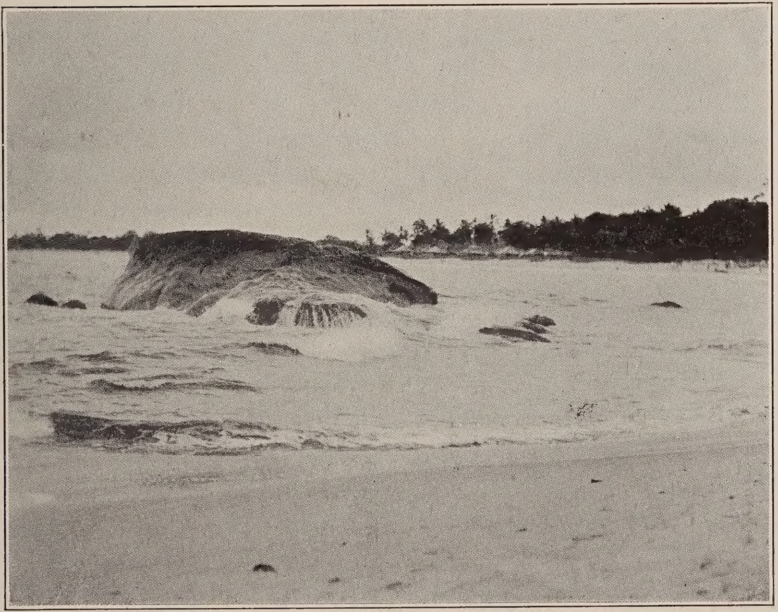
[1] Johnston: *Loc. cit.*, p. 8.

[2] *Ibid.*, p. 482, refers to the highest point in the Nimba Mountains as 6,560 feet which, however, he says is mere guesswork. It is doubtful if there are any hills in Liberia rising even to 4000 feet.



No. 13. — Sino River, portion navigable for small boats



No. 14. — Coast near the mouth of the Sino River

necessary to obtain from water holes sometimes used by animals as drinking places.

It will be obvious that, from the standpoint of hygiene and sanitation, certain of the geographical features of the situation of the coast cities and towns, and the lagoons, tidal creeks and swampy areas about them constitute problems of great magnitude in reference to the control of insect-borne disease. It is also obvious that the geographical features of the interior suggest that it has a more salubrious climate than the coast.

III

CLIMATE

Liberia has one of the rainiest and most humid climates of Africa. The rainy season, which corresponds with the period of the southwest monsoon, begins in April and lasts until November. The rains are usually severe, and the total annual rainfall may be over 170 inches. In parts of Sierra Leone, the adjacent British Colony where the rainfall in the corresponding sections is probably no heavier, the annual rainfall may be as much as 204.5 inches,[1] and in parts of the Cameroon district which has approximately the same altitude, the rainfall may reach the enormous figure of 350 inches, the second greatest in the world.

However, information of scientific accuracy and in sufficient detail to be of great value is almost never obtainable in Liberia and this remark applies to the accurate estimation of the rainfall for long periods of time. The most valuable records available, though they are not extensive, were kept at Mt. Barclay, seventeen miles from Monrovia, approximately eleven miles inland from the coast and at another locality near Monrovia. The earlier of the Mt. Barclay records have been reported by Johnston,[2] and the later ones, which were kept by Taylor for the year 1913, when the annual rainfall was 160.40 inches, by Maugham.[3] The heaviest rainfall occurred in June (20.52 inches); in July (28.85 inches); in August (31.17 inches) and in September (26.63 inches). Ross [4] has also given the records of the rainfall of two and one half years observation (1913–1916) at Monrovia and at twenty miles southward on the coast. He found the total annual rainfall 179.5 inches, of which the precipitation was 170 inches during the rainy season of seven months. He also found that June was the wettest month. The most valuable recent records are those kept at the Firestone Plantations Company at Mt. Barclay and the Du River divisions (see following page).

It is of interest to note that in 1929 the total annual rainfall at Du Division No. 4 was 181.07, with a maximum in September of 41.73. Some records of temperature and rainfall have also been kept at the Holy Cross Mission at Masambolahun in the hinterland. However, at Masambolahun there have been certain difficulties arising from the apparatus and methods employed and the records are too incomplete to be of any value. It might be considered preposterous that there should not be a series of careful government meteorological records of Liberia. It is usually stated, that, as July advances, the rains in Liberia gradually cease, and that by the middle or latter part of the month there is, for two or three weeks very little rainfall. This lower rainfall in July is illustrated in the table of figures given below of the Firestone Plantations Company. The fact is so well recog-

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[1] Giles: "Climate and Health in Hot Countries" (1904), p. 38.

[2] Johnston: *Loc. cit.*, p. 500, (1906).

[3] Maugham: "The Republic of Liberia" (1920).

[4] Ross: The Geographical Review (1919), VII, 388.

Month	*Mount Barclay 1925*	*Mount Barclay 1926*	*Du #1 Division 1927*	*Du #1 Division 1928*	*Du #4 Division 1929*	*Du #5 Division 1929*
Jan.	.72	....	....	1.88	.57	.92
Feb.	.83	....	.82	.18	2.17	3.19
March	5.60	1.73	4.06	4.79	8.97	8.14
April	8.04	13.97	7.26	11.71	10.84	9.16
May	7.43	7.32	10.25	12.20	13.92	7.49
June	26.14	28.30	23.45	25.78	35.86	32.28
July	30.37	19.07	17.67	25.47	21.04	17.71
Aug.	27.73	28.78	15.04	21.73	31.28	13.73
Sept.	23.76	26.87	26.18	32.98 (*#4*)	41.73	24.89
Oct.	15.25	19.56	15.42	16.24 "	8.75	8.02
Nov.	6.38	10.23	6.66	5.10 "	4.94	6.16
Dec.	?	?	Nil	1.92 "	1.00	....
Total	152.25	155.83	126.81	159.98	181.07	131.69
Monthly Average	12.69	12.99	10.57	13.33	15.09	10.97

nized that Americo-Liberians refer commonly to this season as the "middle dries." In some years, however, such a distinct season as this is hardly perceptible in the vicinity of the coast. It is not, for example, shown in the figures recorded by Taylor for the year 1913, and in one year it rained for twenty-five days in July and in another, twenty-nine days. It is well known that the heaviest rainfall occurs just to the south of the trough of low pressure, and so there often tends to be a well-marked double rainfall maximum in the course of the season, — one as the low pressure trough passes north, and the other as it returns south. However, during the whole season of the southwest winds, there is considerable rainfall.

Kendrew,[1] in his studies on the climates west of Lake Chad, speaking of the rainy season of the west coast of Africa, says that Sierra Leone and most of the Liberian coast have only one maximum, the rainfall increasing steadily until August, and then diminishing. This difference from the weather inland, in the same altitude, is doubtless due to the strong summer monsoon from the southwest meeting the elevated coast. The precipitation is greatest when the monsoon is strongest, that is, during the months when the interior is hottest.

The rains of Liberia are generally of the equatorial type, that is, in very heavy showers falling between noon and midnight, and sometimes accompanied with thunder and lightning. At times, however, there are steady downpours for several days or even for a week. Occasionally actual tornadoes occur. They, however, are of a different nature from those which occur, for example, in the western United States. In Liberia, they are generally accompanied by exceedingly heavy rain and lightning, but with less violent wind than in our country. They often start in Liberia very suddenly, and last sometimes only a quarter of an hour. They are especially frequent at the beginning and at the end of the rainy season, sometimes making their appearance after the prevalence of more or less unusual heat.

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[1] Kendrew: "The Climates of the Continents" (1922), p. 33.

During the rainy season there is frequently a foot or two of water on many of the trails in the interior, and across the narrow swollen streams which occur with such frequency and which are rarely spanned by bridges, one must either pass by balancing one's self on a narrow tree trunk or by wading, sometimes up to one's knees or waist or even deeper. Although most of the party soon became very adept in crossing on tree trunks, occasionally one would fall into the water and get as thorough a wetting as if he had waded through the stream.

It is particularly the moisture that renders the climate of Liberia so enervating. On the coast of Liberia no month is entirely free from rain, though December, January, and February are the driest, and February may be almost entirely dry. During the whole rainy season the air on the coast is not only moist, but often saturated, and there are many cloudy days.

From the geographical position of Liberia, it is obvious that its climate is equatorial; the temperature, however, is never excessively high but fluctuates between 75° F. at night and 85° F. at noon or in the late afternoon. Temperatures of 95° F. or 96° F. are not at all unusual, and occasionally temperatures of 100° F. have been recorded. Johnston states that the highest shade-temperature actually recorded in Liberia was 105° F., this was in the region to the north of Sino. Such a temperature must certainly be very unusual. He further states that during the months of December, January, and February, temperatures of 100° F. or 101° F. were frequently registered at noon, and that the night temperature was generally from 80° F. to 83° F. At Mount Barclay, nearly twenty miles from the coast of Monrovia, a temperature as high as 100° F. is unusual, but 95° F. is not very uncommon. The middle of the rainy season is usually recorded as the coolest time of the year. Maugham states that on the seacoast at that time he has seen the thermometer fall as low as 65° F. Days and nights of continuous rain usually cause a drop in the temperature. When such a drop occurs the temperature may not go over 69° F. in the daytime. A temperature as low as 55 F. is very exceptional. During 1929 the following record of humidity and temperature was kept at the Firestone Plantations Company on the Du River. During the period from November to April or May, which corresponds to

1929	Barometer Readings			Temperature Readings		
	Average	*Low*	*High*	*Average*	*Low*	*High*
January		No record			No record	
February		"			"	
March		"			"	
April		"			"	
May (21 days)	30.03	30.01	30.10	85°	77°	88°
June (30 ")	30.06	30.01	30.16	79.95°	76°	86°
July (27 ")	30.09	30.02	30.18	81.41°	73°	85°
August (20 ")	30.08	30.	30.14	78.35°	76°	82°
September (18 ")	30.005	30.01	30.14	77.19°	72°	81°
October (26 ")	29.81	29.02	30.08	72.2°	77°	88°
November (21 ")	29.967	30.	30.04	76.28°	77°	83°
December (—)						

the dry season, the vegetation becomes parched, particularly when the northeast wind, the "harmattan," is blowing, when the atmosphere becomes markedly dry. At that season of the year, although the nights may be a little cooler, the days are often hotter, for the sky is frequently almost cloudless. It is a mistake to suppose that because the harmattan breeze is blowing it is always a cool breeze. These winds, which blow from the Sahara Desert, are extremely dry and often dusty. By the time they reach Liberia their intensely dry character is more or less modified by their having passed over the Liberian forests and the upper Niger region, which is well watered. However, while they are more or less dry winds, they may be either cool or warm. The harmattan has rarely any appreciable effect on the mean temperature, and feels cool to one only because of its dryness and because of the accelerated evaporation of moisture upon the skin which it causes. On the coast these winds sometimes raise the midday temperatures, although they may render the morning and the late evening cooler. In the interior the harmattan may be a hot, dry wind, and it is sometimes accompanied by a haze due to the fine particles of red dust that it carries.

The unhealthiness of the coast is particularly due to the combination of excessive humidity with continuous and considerable, but not excessive, heat. The very severe rainfall and humidity are by far the most important climatic factors in Liberia. Mosquitoes prevail especially after the beginning of the rainy season and at its close. The rainy season is the most unhealthy, particularly on or near the coast, and fever then prevails especially among foreigners who do not take proper precautions and who are less immune than the natives, and to whom the moist heat makes any physical activity particularly disagreeable. Liberia has the reputation of possessing one of the most unhealthy climates in the world, and the coast has long been known as the "white man's grave." An old sailor's proverb says of the coast that "There's two comes out where three goes in."

A great deal, of course, can be done through sanitation to reduce the amount of infectious disease, particularly that spread by the blood-sucking and other Diptera. However, it is the enervating effect of the climate upon foreigners, occasioned by the continuous heat and moisture, that is most noticeable. After nine o'clock in the morning it is unpleasant to walk if one is exposed to the sun, and by ten or eleven o'clock the heat and moisture begin to be noticeably oppressive. One perspires throughout the day, even in the house. In many parts of the tropical world one is quite ready, by five or half past five o'clock, to refresh one's self by exercise by means of some sport. Not so in the villages of Liberia on the seacoast. Here, on account of the humidity and the heat, one must, so to speak, drive one's self to take any form of exercise. When one considers that the towns on the Coast have an average mean temperature of from 76° F. to 80° F. and a seasonal variation of very few degrees, and that the air is so often nearly saturated with moisture, it will be seen that they are not likely to become ideal places of residence for foreigners.

However, the interior of the country is considerably more salubrious. In the interior, the humidity is usually much less. Here also the average maximum temperatures are not above 96° F., and minimum temperatures of 60° F. are not infrequently experienced. Owing to the dryer atmosphere and to the altitude, even though it is not great, one is able to work usually with considerably more energy, and certainly with much greater comfort. However, even in the interior, the hours between eleven A.M. and three P.M. when the sun is shining, are generally somewhat trying if one is walking. From twelve to three P.M. all forms of animal life are seen to seek the shade. The nights, however, after ten o'clock, are usually cool enough so that one may sleep comfortably, and in the interior a blanket is sometimes desirable at night.

IV

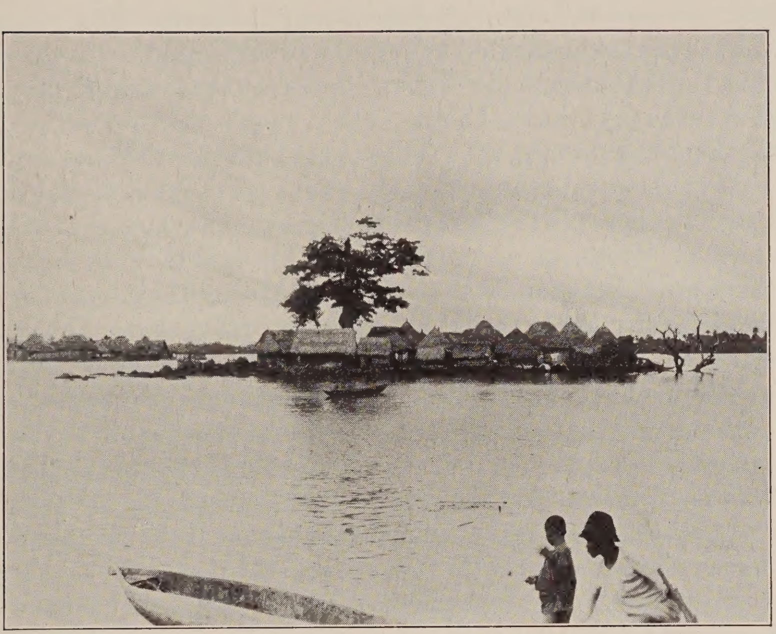
THE INHABITANTS AND CONDITIONS UNDER WHICH THEY LIVE

In 1816 the American Colonization Society was founded in the United States for the purpose of devoting itself to the welfare of some 200,000 slaves who had become free for the most part, either through the voluntary action or the death of their owners. It was thought that the most promising plan was to return them to their native land, and there to found for them a free colony on the west coast of Africa, where they could ever enjoy the benefits of liberty. General Robert Harper of Maryland, who was interested in the proposal, later suggested the name of Liberia (the land of freedom) for the Colony, and for its capital, that of Monrovia, after President Monroe, whose interest and support was evidently desired for the successful establishment of the Colony. After preliminary investigations by the agents of this society in 1818, who visited the coast of Gambia, Sierra Leone and Sherbroo Island on the West coast of Africa, the first consignment of eighty-eight freed negroes sailed for Africa in charge of three white Americans. One of them, a man named Bacon, was an agent of the United States Government who was sent to observe and report upon the organization of the Colony, while another, named Crozer, was to act as the Agent of the Colonization Society. The party finally reached Sierra Leone, and then passed down to Sherbroo Island where they landed with a view to colonizing. Within a short time, however, many of them were attacked by sickness and all the Americans, together with a large proportion of the negroes, succumbed.

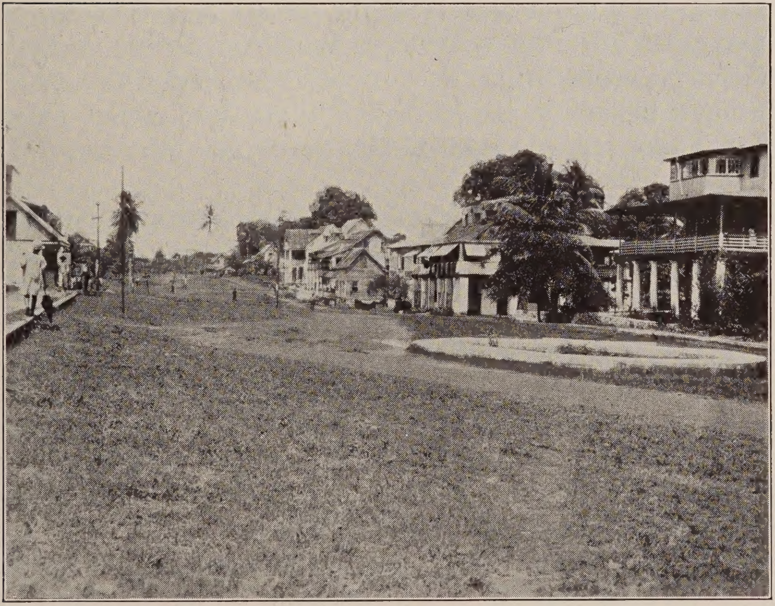
The following year the ship "Nautilus," chartered by the United States Government, proceeded to Africa, with two government agents and two officials of the Colonization Society and a further group of emigrants. These people were allowed by the authorities of Sierra Leone to remain at Fura Bay near Freetown until a site suitable for their colony could be selected.

In the year 1821, Dr. Eli Ayres was appointed Chief Agent of the Colonization Society, and proceeded to Africa with another group of emigrants on board the United States schooner "Alligator." He arrived off Cape Mont Serrado (today usually called Mesurado) with a view to obtaining land for the Liberian Colony. Apparently the first landing of this group was made on what is now known as Providence Island, situated just inside the mouth of the St. Paul River. After some negotiations with the native chiefs, Ayres succeeded in obtaining the whole of the cape on which Monrovia has since been built.

By the beginning of the following April all of the immigrants had been transferred from Fura Bay to the new domain. These colonists, however, also soon



No. 15. — Settler's Island, near Monrovia



No. 16. — Monrovia, principal residential street

suffered from sickness and met with difficulties from the hostility of the surrounding indigenous tribes who desired the return of their land. Though the greater part remained at Mont Serrado (Mesurado) a certain number of the colonists insisted on returning to Sierra Leone.

In 1822 Jehudi Ashmun, who subsequently played such an important and valuable part in the establishment of the colony, embarked at Baltimore on the brig "Strong" with a further company of emigrants, and eventually reached Cape Mesurado. Here, in accordance with his instructions, he assumed the direction and administration of the small colony, and negotiated with some of the native chiefs for more land and for additional privileges. The annual report of the American Colonization Society for 1828 says that large and important accessions were made during the year to the territories of Liberia. It appears, however, that it was necessary later to acquire some land by conquest and that, on several occasions, the surrounding tribes attempted to destroy the settlers or at least drive them from the country. In fact, the early history of the colony was beset with many difficulties caused by the native tribes and slave traders. Disease, however, was one of the greatest obstacles. A good proportion of each new group of immigrants was attacked by fever. Thus, of 105 arriving on one vessel, all were attacked within a month of landing, and but for the treatment and care given them by the Reverend Lot Cary who possessed some medical knowledge, the mortality would certainly have been much higher in the colony than it was. Ashmun[1] says in his journal, that in the case of immigrants who came from Maryland, the disease baffled all the medical skill in the colony. Of 107 who arrived on the ship "Doris," twenty-four died. Lieutenant Gordon of the British sloop of war, "Driver," who went to the assistance of Ashmun in one of his combats with the indigenous natives, shortly afterwards died of fever, and eight of the eleven men who went with him also succumbed to it.

In 1832 a number of state branches of the Colonization Society were founded, with the result that several separate settlements were established along the Liberian coast. Thus a contingent sent out by the Maryland Society in 1831 settled at Cape Palmas and founded the Colony of Maryland, in Africa, and a group from Pennsylvania established another colony at Grand Bassa. A third colony was founded at Sino by settlers from Mississippi, known at first as Mississippi in Africa. In a short time there was more or less friction between these different colonies, but in 1837 all the settlements, except Maryland, joined the central government. Maryland insisted on retaining its independence and did not enter into the union until 1857.

Up to 1847 the government of the Commonwealth was directed by the American Colonization Society, which of course was a private organization. Liberia's right to exercise the powers of government were soon challenged by Great Britain, and in 1843 the British Minister declared to the American Secretary of State that certain differences between British traders and the authorities of Liberia rendered it necessary, in order to avert serious trouble in the future, that Her Majesty's Government should be accurately informed of the degree of official patronage and protection that the United States Government extended to the colony of Liberia, and how far, if at all, the United States Government recognized the colony of Liberia as a national establishment. He also pointed out that the authorities of Liberia had shown a disposition to considerably enlarge the limits of their territory and to assume the right to monopolize trade with the natives along a considerable part of the coast where the trade had hitherto been free.[1]

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[1] Gurley: "Life of Jehudi Ashmun" (1835), p. 382.

From what has already been said, it seems obvious that the United States had given both aid and protection to the early colonists. Also, the American Government gave official assistance to the founding of the Liberian Republic when Congress, in an act in 1819, authorized the President to employ American armed vessels for the suppression of the slave trade along the coast of Africa, and appointed agents resident on the coast of Africa to receive recaptured Africans.[2] In addition, President Monroe sent two agents to cooperate with the American Colonization Society, and the American Government aided in sending nearly six thousand recaptured Africans to the country. The American Government also, on several occasions, sent cruisers to assist the Liberian Government in the suppression of native revolts and to prevent foreign intervention.

In reply to the letter from the British Minister, referred to above, the American Secretary of State informed Her Majesty's Government that the United States regarded Liberia as occupying a peculiar position and as possessing claims to the friendly consideration of all Christian powers; that the United States would at all times be prepared to interpose its good offices to prevent any encroachment by the Colony on any just right of any nation, and that it would be very unwilling to see it despoiled of its territory rightfully acquired, or improperly restrained in the exercise of its necessary rights and powers as an independent settlement.[3]

After considerable discussion it was agreed by those most interested in the Colony and especially by the settlers themselves, that a fully independent government should be recognized, and the American Colonization Society severed all political connections with Liberia in 1846.

In 1847 a declaration of independence was made by the settlers, in which, after discussing the disadvantages and hardships which they had undergone in the United States, they recited their desire and their right to establish the Republic of Liberia. The constitution was evidently drafted with the Constitution of the United States as a model. It contains a declaration of rights, defines legislative and executive powers, and outlines the organization of a judicial department much in the fashion of our own constitution. Section 12 provides that "No person shall be entitled to hold real estate in this Republic unless he be a citizen of the same" (which obviously excludes all white persons) and Section 4 states that there shall be no slavery within the Republic.

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[1] American Journal International Law (1910), IV, 211.

[2] United States Statutes at large (1813–1823), III, 532.

[3] *Ibid.*, p. 214.

The flag of the Republic of Liberia, also patterned after our own (red, white, and blue), consists of six red and five white alternating stripes, indicating the eleven signatories of the Declaration of Independence, and of a single white star on a blue field in the corner near the spearhead of the staff. The national shield bears at its foot the national motto, "The love of liberty brought us here."

Great Britain almost immediately (1848) recognized the independence of Liberia; France, Prussia, and a number of other European countries did so shortly afterwards. The United States, however, did not officially recognize Liberia until 1862, when the great issue of slavery was being fiercely contested. At the present time Liberia is represented in this country by a Consul General at Baltimore, a negro who was formerly Minister of the United States to Liberia. There is also a white Consul for Liberia in New York.

The Constitution drawn up in 1847 remains with few amendments the law of the country today. There is a President who is Commander-in-Chief of the Army and Navy, and the Constitution also provides that he shall have other powers somewhat similar to those held by the President of the United States. At present, however, there is no Liberian navy, though several years ago there was one armed steam yacht. The army consists of about six hundred men known as the Liberian frontier force. As organized on paper, it is divided into two battalions with two labor companies of twenty-five men each. Enlistment is for a period of five years, and pay is at the rate of about one English pound a month. Both officers and men, however, complain bitterly of the arrears in their pay, and have done so for some years.[1] They sometimes use this fact as an excuse for their depredations against the native tribes.

In 1912, the American military attaché at Monrovia reported that the members of the Liberian frontier force were neither fed nor paid, and that for the last three years their pay had been "jobbed" by Liberian officials. He also reported that in the past the officers in the force also acted as native commissioners, and as such had "stolen from the natives their women and children, killed their men, purloined their food, ivory and other possessions and in general had brought about all the dissension and wars waged on the frontier, together with the defection of the natives." [2]

There is also a Liberian militia in which about three thousand men are enrolled. A company drill is scheduled to be held once a month, but is frequently dispensed with. The regulations also require four regimental parades a year. The men are not equipped with serviceable arms and neither officers nor men are paid.

The Constitution of Liberia also provides for a Vice-President who presides over the Senate, and for a cabinet in which, like our own, there are seven secretaries— State, Treasury, Justice, War, Interior, Public Instruction, and Postmaster-General. The Legislature consists of ten senators (two from each county) and twenty-one representatives. The judiciary consists of a supreme court of three judges and of four provisional courts. In addition, each county has a monthly court and judge as well as a justice of the peace. There is also an Attorney-General and a Solicitor-General. The Liberian judicial system has been subject to most serious criticism, and a number of complaints have been made by foreign nations.[1] It is impossible to tell from the Liberian estimates what disposition is made of judicial fines and fees, and the judiciary system has cost at least in some years, nine per cent of the total revenues of the country. No lawyer in Monrovia would dare to apply for an injunction against a prominent government official. Despite the absence of a law school, there are more than one hundred negro attorneys in Monrovia alone.

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[1] Report of the Secretary of the Interior (1923), p. 2.

[2] Foreign Relations of the United States (1912), p. 655.

It has been estimated that up to the time of the Civil War, 18,858 negroes had emigrated from the United States to Liberia, through the efforts of the American Colonization Society. In 1865 as a result of the war, negro emigration from America to Liberia almost entirely ceased. In the same year, however, 346 emigrants were brought to Liberia from the British West Indies and in the succeeding years, several thousand more from the United States arrived. It is the descendants of all these people that constitute the "Americo-Liberians" of today, who are usually estimated now to number between ten to twelve thousand. However, the Americo-Liberians have for many years intermarried freely with members of the indigenous African tribes coming from the interior and living in the vicinity of the coast, and the usual estimate is that there are in the neighborhood of fifty thousand people residing on and near the coast who have some knowledge of the English language and who, in the language of the country, are regarded as "civilized."

Attention has been called to the fact that, in recent years, emigration from the United States to Liberia has been exceedingly small. The opportunities for negroes in the United States have been so numerous and so superior to those in Liberia as to amply account for the fact. Indeed, a large number of the more influential Americo-Liberians do not wish for the immigration into their country even of intelligent and educated negroes from the United States. The reason for this feeling may be partly seen in the fact that the total revenue is so low and the number of office seekers so large, that a very high percentage of the government receipts are consumed in the payment of salaries to administrative officials and employees who, of course, are all negroes.[2] The Americo-Liberian realizes that any intelligent newcomers from America would have to be cared for with government salaries and sometimes assumes that such newcomers might regard themselves as more intelligent and capable than the natives and insist on taking over government positions or on taking advantage of other financial opportunities.

It has been estimated that in addition to the Americo-Liberians, there are between one and a half and two million indigenous Africans in the country.[3]

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[1] Messages of the President of Liberia (1904), p. 9: (1908), p. 16: (1922), p. 13.

[2] Buell states ("Native Problem in Africa" (1928), vol. II, p. 729) that about 90 per cent of the Government receipts are consumed in the payment of salaries of Government employees. However, according to the Liberian Government budget in 1929, the amount expended for salaries was $621,000.00, and the total budget $1,264,000.00.

[3] Johnston: *Loc. cit.*, Vol. II, p. 886, gives the indigenous population as 2,000,000.

These figures, however, can only be a rough estimate. Some recent writers like Maugham and Jore[1] suggest that the population numbers between six and seven hundred thousand. Buell[2] points out that if Liberia has the same population density as Sierra Leone, namely 56.2 per square mile, the total number of its inhabitants would be two million, three hundred and fifty thousand. No census of any kind has been made in the country, and the election returns are to an extraordinary degree fictitious. For example, the number of property owners eligible to vote in Liberia has been estimated at about six thousand, but in the presidential election it was said that there was a total of fifty-one thousand votes cast, of which the President-elect received forty-five thousand. In 1927 it was stated that the majority of the President was one hundred and twenty-five thousand votes.

The Americo-Liberians live almost entirely on the coast, for comparatively few of the government officials, with the exception of the District Commissioners, reside in the interior of the country. Some five thousand of them reside in Monrovia. More than half of them live either in the capital or in the county of Mesurado, particularly in the St. Paul River settlements. The greater part of the remainder are found in the half dozen other more important towns and villages on the coast, — Grand Bassa, Sino, Sangwin, Grand Cess, Cape Palmas, and Cape Mount.

The character of the towns on the coast and the life and customs of the people in them are in many respects similar. Monrovia, however, being the capital, is the most important center politically and also commercially. The town is built along five streets running parallel with the Mesurado Lagoon; the lower part where most of the business is conducted is built on the lowest of the streets which run along the waterfront. These five streets are crossed approximately at right angles by four others, which are usually hilly and uneven and by which one ascends sometimes by rude stone steps to the residential section of the town, some two or three hundred feet higher up. Only one is paved; the remainder have more or less grass or low vegetation growing in them, and some are rocky and uneven in places. There are no pavements but at the sides of the streets are gutters which at some seasons of the year contain water and serve as breeding places for the mosquitoes which transmit malaria, yellow fever and filariasis.

Most of the residences are of two stories (exceptionally of three), built generally of wood, though sometimes of brick, and have corrugated iron roofs or sides. They usually have wide verandas which are covered for protection against rain and sun. Many of the houses have small flower gardens. A number of them, particularly in Monrovia, are of fine appearance and good construction, and are comfortable as residences, as, for example, the executive mansion, which is the most striking and imposing residence in Liberia (No. 21). It is, however, not owned by the government but is rented by it for $1200 a year.

A number of foreign business firms and some of the diplomatic representa-

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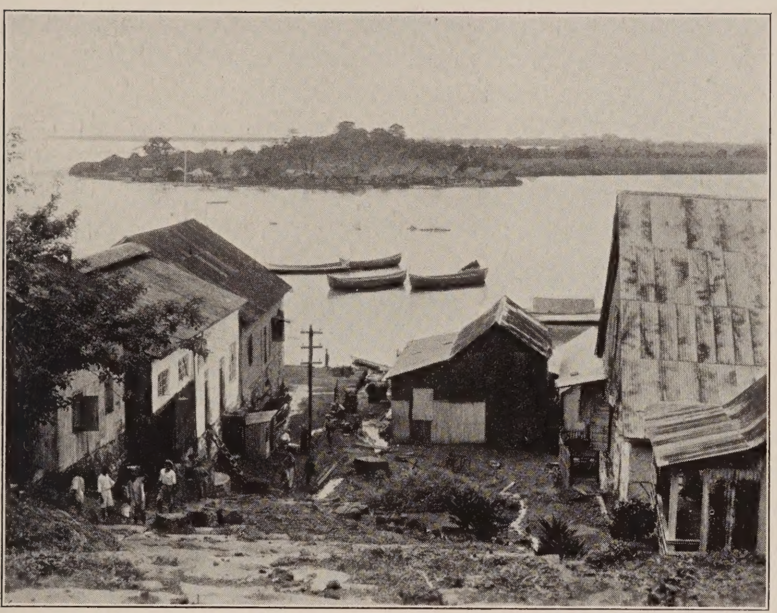
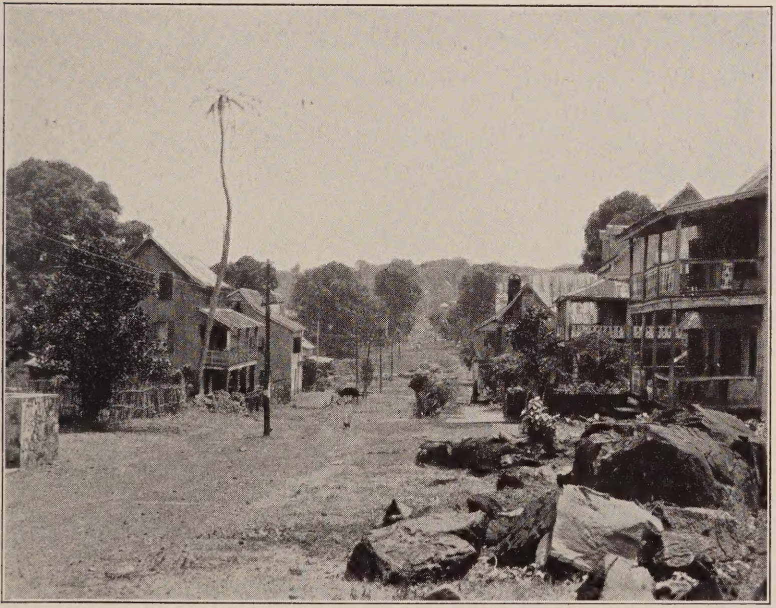
[1] Jore: La République de Liberia, Paris (1912), p. 28.

[2] Buell: "The Native Problem in Africa" (1928), Vol. II, p. 705.



No. 17. — Monrovia, street ascending from lower to upper portion of town



No. 18. — Another residential street

tives also occupy comfortable residences or offices, some of which are constructed of concrete. Among the larger buildings is a two-story wooden house with verandas, which has recently been put to use as a general hospital and which, when we were in Monrovia, contained several patients.

About half a mile from the center of Monrovia is Monrovia College which was founded in 1921 by the Bishop of the African Methodist Church. It is established in a large concrete building, three stories in height, and surrounded by verandas. It was erected at considerable expense and intended as an industrial institution. All the money is said to have been spent upon the building, and none was left for equipment and running expenses. There are less than one hundred students in attendance and the school has recently suffered from decided differences of opinion regarding administration. There is no other building of such magnitude and character in Liberia (No. 22).

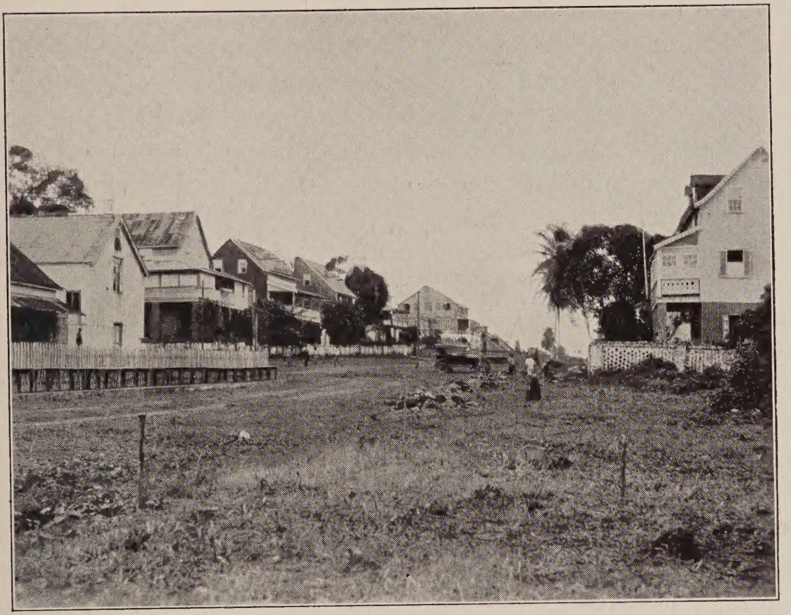
Unfortunately there is no running water in any of the houses, no general water supply, no system of sewage disposal, and no modern plumbing. The drinking water is supplied largely from wells or cisterns which collect the rain water.

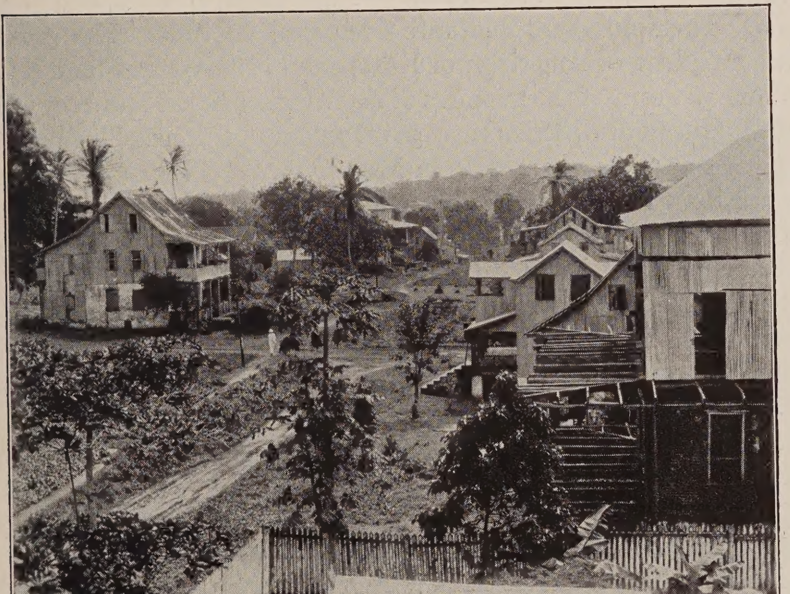
There is a large cemetery on the outskirts of the city and between it and a part of the residential quarter is an undrained and unsanitary swamp, sometimes used for washing clothes. Numerous larvae of mosquitoes, notably of Anopheles, were found in this swamp.

In spite of these unpleasing and unfortunate conditions, Monrovia has in a number of other respects an attractive appearance. Its scenic charm lies particularly in its vegetation. Flowering shrubs and trees, such as oleanders, frangipani, acaciae with scarlet blossoms, and other flowering leguminous trees with yellow or red blossoms are growing here and there. Many tropical fruits are also seen growing about the houses, though not in great abundance. Among them may be noted pawpaws, mangoes, breadfruit, bananas, and plantains, oranges, limes, avocado pears, a few pineapples, and an occasional coconut tree. Everything that grows well and requires no cultivation and almost no attention may be found, but the Americo-Liberians are not good agriculturists or gardeners. Physically they are lazy, and the amount of agricultural produce raised by them is exceedingly small. Those who can afford to, live chiefly on imported and tinned food. In the markets one does not find a great variety of fresh vegetables but usually only cassava, yams, and plantains, or occasionally a little sugar cane and red peppers. Poultry is procurable but is not abundant; the raising of chickens on a large scale is neglected. Cattle are very scarce in the coast towns, and sheep are relatively seldom seen. Goats, however, are numerous.

Fortunately there are certain more modern institutions in Monrovia which contribute greatly to the comfort and convenience of visitors and residents. Among them are a small ice plant and an electric light plant. Monrovia also has a telephone system, and cable and wireless communications with the outside world.

There are several printing presses. Buell, who investigated this, states that,





Nos. 19, 20. — Illustrating condition of other streets and character of houses, Monrovia directly or indirectly, the government controls every printing press in Monrovia except the one belonging to the Methodist Mission. It frequently exercises censorship. He reports [1] that during the 1923 campaign, in which the President was being vigorously opposed for reelection by candidates of the People's party, his opponent wrote a letter to the United States describing conditions in Liberia. The administration removed this letter from the post office, and the President read extracts from it during the election campaign. After the election, the author of the campaign letter sued for its recovery. The circuit judge, unfamiliar with the fact that the President was not amenable to judicial process, issued a mandamus ordering the President to deliver it up. When the President heard of the summons he is said to have called the judge, the attorneys involved, and the sheriff to the White House, and after lecturing them upon the omnipotence of the President, fined the judge $150, and the other offenders similar sums.

There is a government post office in Monrovia, and the Postmaster-General is a member of the cabinet. However, it is generally not considered safe to mail foreign letters in this post office, since the stamps are sometimes removed and resold, and the letters themselves have a way of disappearing. Foreigners usually prefer to carry their letters out on surf boats and to mail them on the steamers which ply up and down the coast.

The only bank in the country is the Bank of British West Africa at Monrovia. English currency is used. There are between one hundred to one hundred and fifty white people residing in Monrovia — Americans, English, and Germans predominating. Their numbers fluctuate from time to time. The great majority of them are members of American or European business firms, and it is said that only about one per cent of the business of Monrovia is in the hands of the Americo-Liberians, almost all of whom occupy government positions. The diplomatic and consular representatives also reside in Monrovia.

There are some half dozen good-sized churches in the town, for the Americo-Liberians are excessively religious. Almost without exception they belong either to some branch of the Protestant Church, or to the Roman Catholic Church, and the Sabbath is well observed by large attendance at the churches. Unfortunately, the standards of life in the towns are generally not high or ennobling or apparently governed by high ideals, although there are some people of fine character.

Unfortunately there is no book store in Monrovia. Nevertheless, some of the people are very well educated and a few are especially able. The Americo-Liberians, as a class, do not take much physical exercise, and do not engage to any extent in sport or do much gardening.

In addition to the Americo-Liberians, there are residing in Monrovia and other coastal towns, a number of negroes from British possessions in West Africa, such as Sierra Leone, the Gold Coast, and Nigeria, and there are a few also from the West Indies and British Guiana.

In other towns on the coast, such as Cape Mount, Marshall, Grand Bassa, and Sino, conditions prevail similar to those which prevail in Monrovia, though

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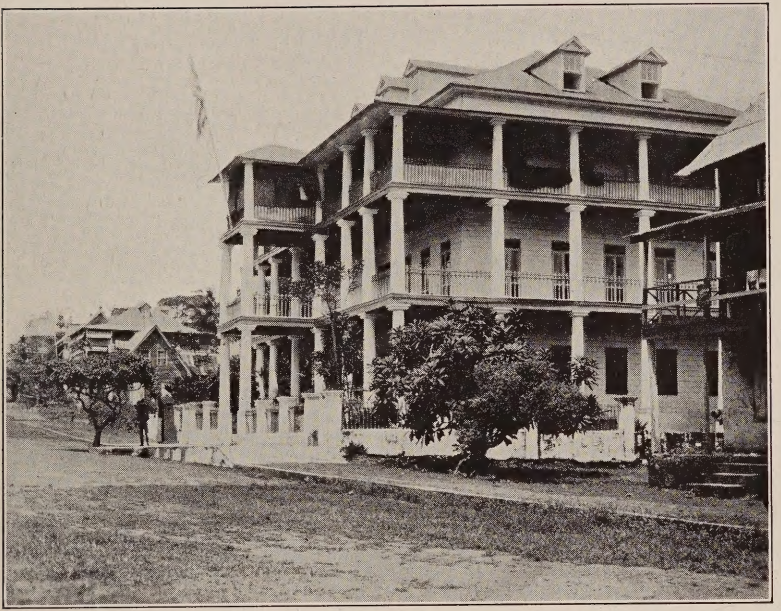
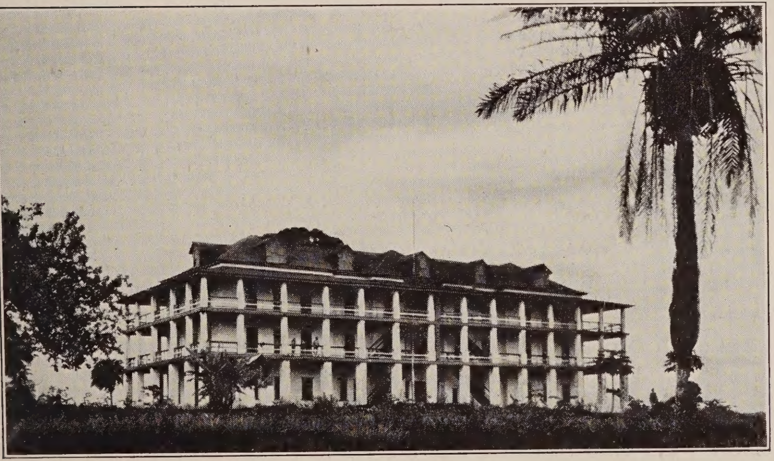
[1] Buell: *Loc. cit.*, p. 711.



No. 21. — Residence of the President of Liberia



No. 22. — Monrovia College

as these communities are smaller, life is somewhat more primitive. Besides the Americo-Liberians and indigenous Africans there are in these towns, a few white people who are largely traders. The business life in them centers in trading; palm oil, palm kernels, piassava fiber, rubber, cacao, and coffee are chiefly exported.

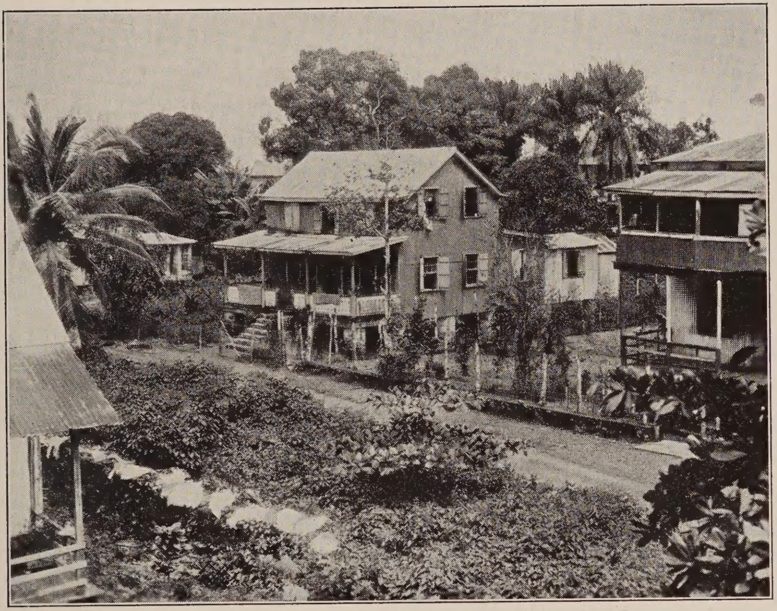
The terms "civilized" and "native" are still used colloquially by the Americo-Liberians to designate respectively those people living on the seacoast and speaking the English language, and those still belonging to the indigenous African tribes that live in the interior and speak a native dialect. At present the seacoast of Liberia, inhabited by the "civilized" population, is divided up into counties — the Mesurado, Cape Mount, Sino, Grand Bassa, and Maryland, the territories of Cavalla, Marshall, and Careysburg, and the commonwealth district of Monrovia. Except for Mesurado, each county and the districts of Marshall and Careysburg are in charge of a Superintendent appointed by the President.

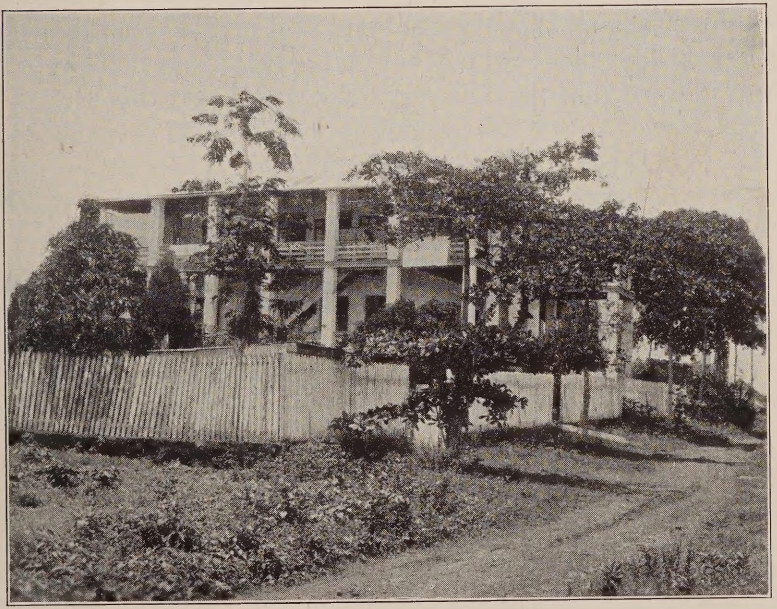
The government of Monrovia is in the hands of a Commissioner and a Municipal Board composed of the Superintendent of Police, a Director of Public Works, and a Sanitary Inspector, who, however, has no medical or special sanitary knowledge.

The revenues of the city are derived from a portion of the real estate and poll taxes collected, and from a large number of petty fees, including lawyers' licenses at twelve dollars a head. One of the largest items in the recent budgets has been from liquor licenses, a sum that in 1926 was estimated to be $3800. Instead of charging for the use of electric light system by the meter, the city levies an electric light tax of one dollar a year on every native man in the vicinity of Monrovia, whether he uses electric light or not. This taxation has been strongly objected to, especially by members of the Kru tribe who live in the adjacent Kru Town, and who do not use electricity. There is also an education tax of one dollar for the upkeep of the schools which, however, is not extensively collected.

According to the assessed valuation, the property of the District of Monrovia should return to the government an annual tax of more than $65,000, but the real estate tax for the whole of Liberia in 1922 was only $1,053; and in 1923, but $721. In the County of Sino, thirty-nine Americo-Liberians in 1924 paid a tax of three cents each on their property, whereas the remaining taxes on the Americo-Liberians ranged usually between ten and twenty-five cents. Following the administrative investigation in 1923–1924, the total tax was increased to $4,688. In comparison with this the hut taxes imposed on natives in the interior of the country in 1925 amounted to some $300,000. Each tax collector in the interior receives as a fee fifteen per cent of the tax collected but it is said that the collectors frequently divert the entire amount to their own use. Recently the appointment of all tax collectors has been placed in the hands of the President.

It is interesting to note that the hinterland of Liberia is not represented in the Liberian legislature, but upon the deposit of one hundred dollars a tribe may send a referee to watch the legislative proceedings of the Americo-Liberians at





Nos. 23, 24. — Monrovia, types of houses and vegetation about them

Monrovia. The referees may not vote, but they may speak every Friday on such affairs as affect their tribes.

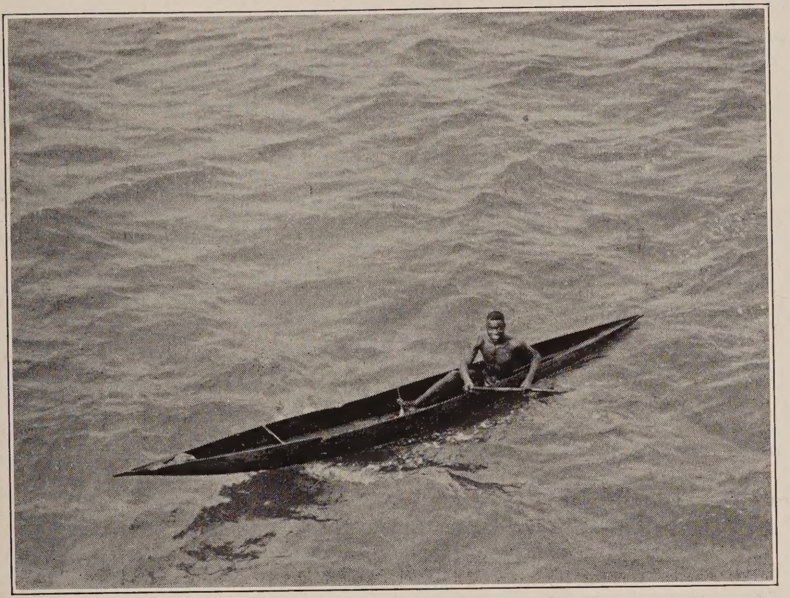
It has been estimated that the total number of Americo-Liberians transported to Africa probably does not exceed twenty-five thousand. It seems, however, that the old Americo-Liberian families are gradually dying out in part through disease and a low birth rate and in part through polygamy with women of the aboriginal tribes. There is today no clear-cut distinction between the Americo-Liberians and many of the million and a half subjects over whom they rule. Intermarriages have frequently occurred between Americo-Liberians and indigenous natives, and the Americo-Liberian and aboriginal African children often attend the same school. This assimilative process has been going on for years, and more and more the sons of the natives of the interior have entered school, acquired an education and attained prominence in the affairs and life of the Republic. Because of the decreasing number of Liberian families who have not intermarried with aboriginal tribes, the aboriginal children in the schools now far exceed in number the children of Americo-Liberians. According to one estimate, all but six hundred out of the nine thousand children said to be in school in Liberia are aborigines.

A number of Americo-Liberians, however, still maintain an attitude of high superiority toward the interior native population, and certainly the education and living conditions of the residents of the coast are entirely different from those of the natives of the interior. Nothing of any importance has been done by the Americo-Liberians to improve the condition of the natives. On the other hand, much has been done which has actually retarded their development. Nevertheless, it is obvious that Liberia cannot be successfully developed without the aid of the interior tribes, a brief description of which will now be given.

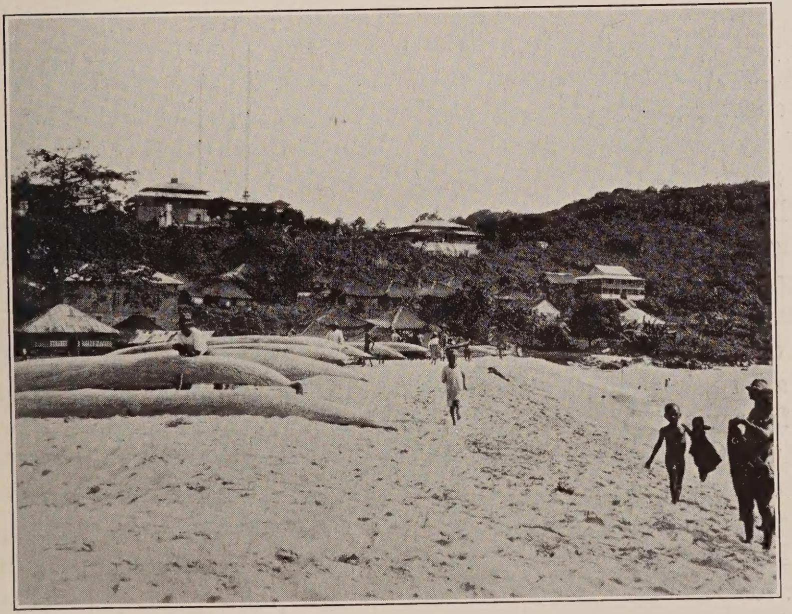
The Indigenous Inhabitants. The aboriginal or indigenous natives of Liberia who constitute somewhere in the neighborhood of ninety-seven per cent of the population belong to a large number of tribes. They have been studied particularly by Johnston, D'Ollone, Delafosse, and Westermann, and have been roughly divided into three main ethnological groups, the Mandingo, the Kru, and the Gola (Gora). In the Mandingo group, a mixture of Fula and native Liberian stocks, are included the pure Mandingo, the Vais, Kpwesi, Buzi, Mendi, Gbandi, and Gbundi tribes. In the Kru group, representing the original stock of West Africa, are particularly included the more important tribes of Krus, Bassas, Des, and Grebos. Delafosse has divided it into eighteen smaller tribes. The third ethnological group includes the Gola and Kissis tribes which, from the character of their language, are presumed to have belonged to one of the original black races of West Africa and perhaps to be allied with the Temne and Bulom tribes in Sierra Leone.

No attempt will be made here to give any extensive ethnological or anthropological description of these different groups. Only a few of the more striking characteristics will be mentioned, and in the main only of those tribes among which the work of the Expedition was carried on.

The Krus are a coastal people. Many are boatmen and fishermen; others



No. 25. — Kru boatman



No. 26. — Beach on the edge of Kru Town

serve as deck hands and cargo workers on the various steamers which ply back and forth along the West African coast, and still others are employed as laborers about the vessels in the ports themselves. It is customary for the Kru boy to enter service on the European steamer as it reaches Freetown or Monrovia, and to leave the ship at either of these ports on the return trip. Apparently much attached to their own land, they return, as a general rule, to their villages after each voyage. About their villages on the coast there are always a number of canoes and fish nets and traps. They are negroid, thick and sturdy and unattractive in appearance but they are a hardy, virile and industrious race. It is said that they have always especially resisted slavery. Their tribal mark consists of a broad blue band between the center of their forehead and the bridge of the nose and is produced by making a number of sharp cuts with a knife and then rubbing charcoal or indigo into the wounds. When the cuts are healed there is often a slightly raised scar, dark blue in color. The Krus call it their mark of freedom. In addition they sometimes make two blue triangular marks starting from the outer corner of each eye, and extending to the edge of the cheek bone. These are said to be distinguishing Kru marks. The Krus particularly delight in wearing the white man's cast-off clothing and usually possess one or two articles, such as a dilapidated hat, a ragged pair of trousers, or a singlet or trunks of soiled underwear. They are not farmers, and neither the men nor the women pay any special attention to the cultivation of the soil, though sometimes a small amount of mandioca and a few yams or plantains are found growing in their gardens. Occasionally the Kru women do some work on the farms further in the interior. Their diet consists in general of the vegetables mentioned, which they raise, breadfruit, and particularly of fish, much of which is dried. The Krus live along the coast, particularly in the stretch between Garawé and Grand Bassa, and are especially numerous in Sass Town, Nana Kru, Settra Kru, and Kru Town.

Their most important village, Kru Town, is built on the sands at the foot of the hill on which Monrovia is built. It is a town of rather dilapidated small houses, constructed of wood or sometimes of thatch and many have tin or corrugated iron roofs. The streets are merely narrow lanes. It is estimated that there are between three and four thousand people living in Kru Town at different times. It has its own governing body, but the Governor, although a Kru, is appointed by the President of Liberia. Each ship taking on boys at Monrovia, pays to the Liberian Government one dollar head money per boy, and the Government is said to receive between twenty and twenty-five thousand dollars in some years from this source. Ship agents assert that this head money is deducted from the boy's pay. On his return to his village from the boat, the Kru boy pays one shilling into a municipal fund used by the Kru Town Governor. A sanitary tax of three and one-half shillings is also imposed. It is not clear in what way this money is expended but it is certainly not spent on sanitation. As the central Liberian Government also collects an electric light and poll tax the Kru boy or man is lucky if he retains half of his earnings.

In addition to furnishing Kru labor for boats and steamers, Liberia also furnishes Kru labor for plantation work at Fernando Po. This arrangement was

No. 27. — Adult Kru

No. 28. — Group of Kru children

entered into originally by a convention arranged by the Liberian and Spanish governments.[1] The recruiting agent in Liberia is paid five dollars for each Kru boy recruited. The boys are brought to the steamer three days before she sails. The maximum length of contract is two years and the mimimum one year. Half the wage is paid monthly to the laborer at Fernando Po. The second half is to be paid the boy on the termination of the contract. Whether he receives this half on his return to Monrovia is said to depend on the honesty of the officials concerned at the Spanish Consulate, and of the Liberian agent. The boys do not, as a rule, read or write. So much dissatisfaction has resulted from the arrangement, and there has been so much criticism regarding compulsion, that fewer and fewer Krus are being sent to Fernando Po under the convention.

The Bassas are another tribe related to the Krus and are somewhat similar in appearance. They often have broad noses, are prognathous and thick-lipped. However, they speak their own dialect, though it has resemblances to that of the Krus. They live chiefly to the east of the St. Paul River behind Monrovia, and in south-central Liberia as far eastward as the Sangwin River. They are particularly numerous in the basin of the St. John River. The Farmington River forms roughly the northern boundary of their country. Although they do not seem to be particularly intelligent as a race, there have been exceptions; recently one of the cabinet ministers and a member of the faculty of the Liberian College were both educated Bassas. In fact, the Krus and Bassas have apparently produced more highly educated men than the other tribes in the interior of Liberia. The Bassas make good sturdy laborers. They have the same tribal mark on the forehead as the coastal Krus, but they frequently tattoo their chests with two blue stars and a broad horizontal line.

The Grebos, a third branch of the Kru group, who also have their own dialect, are found mainly in the territory round Cape Palmas and up the Cavalla River. Like the other Krus they are sturdy and black or dark brown in color. They have devoted themselves particularly to farming, hunting, and fishing. They seem to be a people among which the work of the missionaries has latterly found special encouragement; many of them near the coast are now Christians and have received education in the mission schools. One of the Grebos has become County Attorney at Mesurado Colony, and two are judges, one at Grand Bassa and one at Cape Palmas. The less educated members of the tribe have in the past been especially superstitious, and have assumed more or less independent attitudes toward the other people living in the vicinity. Among them great stress has been laid upon the medicine man and the devil man, or "deya" who is supposed to be able to find out anything, and is especially able to detect the person guilty of a crime. Death among the Grebos is believed to be caused generally by witchcraft; any one of the tribe may be suspected of causing the death and run the risk of being examined and convicted by the "deya." Their medicine men are also said to have a wide knowledge of roots and herbs and especially of those that are poisonous. In addition they often act as advisers to the Chiefs. The Grebos have many tribal customs among which is a special

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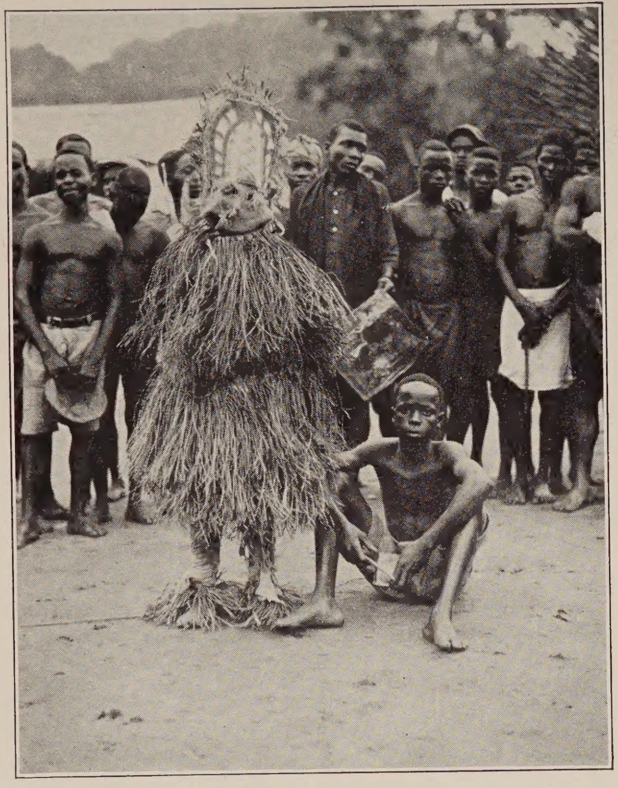
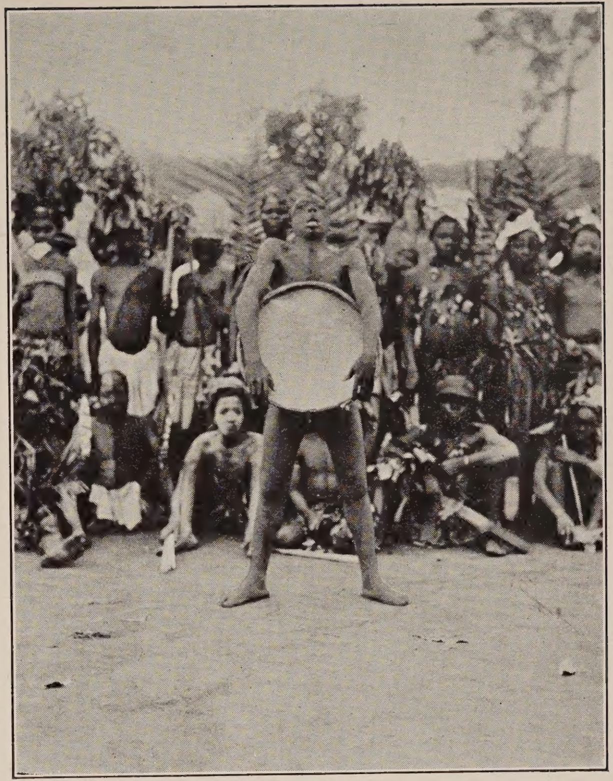
[1] Message of the President of Liberia (1914), p. 12.



No. 29. — Group of Bassas with their devil



No. 30. — Group of Grebos at a fête with clown in foreground

clan system that will be referred to later. But as they become more and more civilized these special customs are fast disappearing.

The native houses are usually built of the raffia palm ribs and fronds. They are generally plastered with clay on the outside and decorated with striking patterns in black and white. The floor is raised above the level of the ground outside, and is of solid clay, not of planks as is often the case among the other Kru peoples. Their dwelling houses are often circular in shape, but are sometimes oblong.

The Grebos especially in the past have resisted Americo-Liberian administration and control, sometimes to the point of revolt. As late as 1915, hostilities between the Liberian Government forces and the Grebos occurred, in which the Liberian Government found it necessary to ask for the assistance of the United States and for the services of an American warship.[1] The American officials in Monrovia declared, however, that they would only make this request of the United States on condition that the Liberian Government would reform its administration of the interior. Upon this promise being given, the request was forwarded to the American State Department. In November, 1915, the United States S. S. "Chester" arrived in Monrovia. The President of Liberia then appointed a Commission made up of three Liberians and the American General Receiver of Customs to settle the Kru (Grebo) dispute. This Commission proceeded on the "Chester" to the scene of the revolt, and Captain Schofield, the commander of the vessel went to the armed camp of the Krus to investigate the trouble. He reported that the administration of the natives had been tyrannous, that only twenty-five per cent of the taxes collected had ever reached the central Government, and that the Krus had been subjected to a large number of petty abuses. The Krus insisted that the Liberian soldiers should be taken back to Monrovia, and that no taxes should be imposed on those of their towns for which the Liberian Government did nothing. The Commissioner ordered the Krus to cease hostilities, to give up their guns, and to surrender, but the rebels, confident in their strength and expecting to receive help from the British, decided to fight. Liberia, not being in a position for hostilities, again implored aid from the United States with the result that our War Department sent five hundred Krag carbines and two hundred and fifty thousand rounds of ammunition to be sold to Liberia at half price. Thus supplied with arms, the Liberian frontier force decimated the Kru population and subsequently hanged some Kru chiefs. The severity of the punishment was so great that some Catholic missionaries made a protest to the British Foreign Office. The Liberian Government, having received the aid from the United States which enabled it to crush the rebellion, then declined to carry out those reforms in its methods of dealing with the indigenous tribes, which it had accepted and agreed to when in need of help.[2]

The Mandingoes constitute a tribe that accepts the Mohammedan religion, and that is perhaps the most intelligent in Liberia. In the main they probably owe their racial characteristics to interbreeding between the Fulas and the

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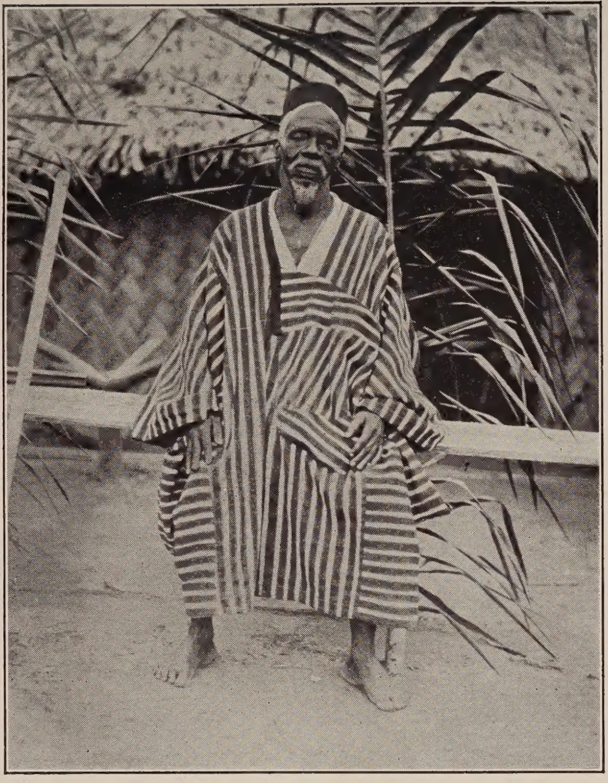
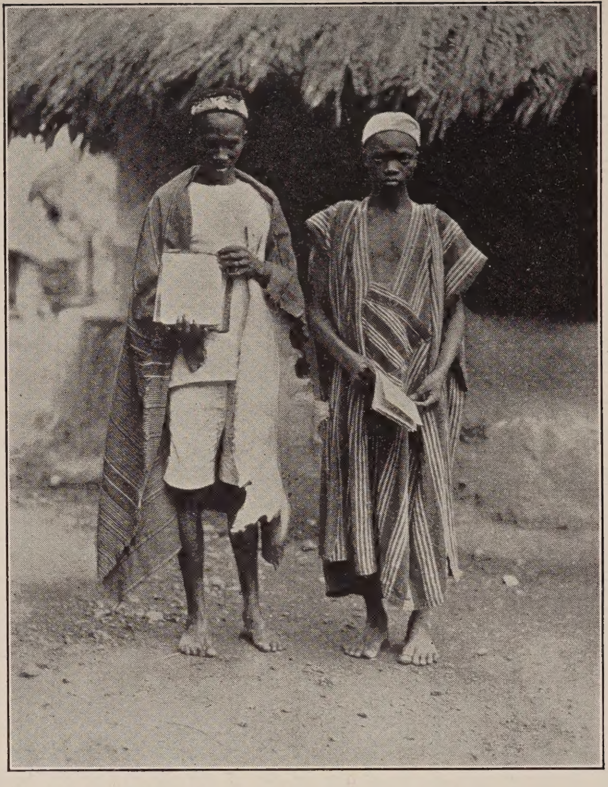
[1] Foreign Relations of the United States (1915), p. 627; (1916), p. 455.

[2] *Ibid.* (1917), p. 878.



No. 31. — Mandingo patriarch



No. 32. — Mandingo boys with Koran leaflets

women of the pure negro tribes. The Fulas, a semi-Caucasian race, apparently resulted from one of the first invasions of negro tribes in the western Sahara by the Libyans (Moors) of northern Africa, who interbred with the pure negroes. The Fulas, though proud of their light color, did not hesitate in turn to mate with the women of negro tribes as well as with those of their own stock, and so gave rise to a number of negro hybrids, who possessed darker complexions but features that showed the intermingling of Caucasian blood. The Mandingo is one of the most notable of these hybrids, though owing to the intermixture of its Fula blood with the Teware and the Arabs from the north of the Niger, and with the western Sudan negroes, the race is of very mixed origin.

At some remote time the Mandingoes developed a very distinct group of languages with grammatical structure, represented today in a number of different tongues and dialects in interior West Africa, as well as by a few in Liberia.

The Mandingoes, evidently having became Mohammedanized at an early period, later introduced their religion into Liberia, together with some of the customs of Mohammedan civilization, including the use of clothing. Also at a remote period the Mandingoes apparently pushed their way toward the seacoast, perhaps in search of salt, and reached the northwestern part of Liberia and the eastern part of Sierra Leone. They have left traces of their earlier incursions into Liberia, particularly in the existing Mendi and Vai tribes, whose languages bear certain resemblances to that of the Mandingoes. Johnston states that probably by the interbreeding with other negroes, they in their turn are the forbears of the Gbandi, Susu, and Kondo tribes. Thus apparently through the Mandingo a small part of Caucasian blood and a trace of Caucasian civilization reached the unadulterated negroes of prehistoric Liberia.

The Mandingo people, who though some are almost black, are usually of a light or dark shade of brown, are found in especial abundance in the most northern parts of Liberia, and are really the dominant people in the regions between the St. Paul River and the Sierra Leone frontier. A wandering people, they are gradually invading the villages of a number of other tribes, and one finds their separate villages sometimes built within a hundred yards of the village of the native tribe of the region. We found such a condition of things both at Gbanga in the central portion of Liberia among the Jarquellis, and at Tappi Town in the east-central portion of Liberia among the Gios. Being well disposed toward the government of the Republic and ingratiating in their manner, they are not molested in their new settlements. They are astute traders as well as great wanderers; they bring cheap cotton prints, particularly those of bright color, suitable for dresses and other clothes, across the border from French Guinea and trade them for kola nuts which they often send to their starting points or take back with them. They do considerable weaving of cloth, and in the northwestern part of the country where the industry is practicable, they raise a few cattle and horses. Being Mohammedans, they are observant of their daily religious exercises and may be seen kneeling and praying, both morning and evening. They are also strict in their avoidance of alcohol. They are superstitious and many of them wear amulets round their necks containing verses of the Koran sewn up in leather packets. Polygamy among them is of course universal, and boys and girls are allowed to cohabit before marriage. A female companion is often provided for a boy by his parents.

The clothing of both sexes of the Mandingoes is much more abundant than that of the other Liberian tribes. The men wear very baggy trousers which are sometimes tied over the calves, and which are very loose in the seat and more or less Moorish in appearance. Outside the trousers a sleeved shirt, either white or of some fancy material, is worn, and over this finally an ample loose-sleeved garment sometimes called a kaftan which has a hole in the middle through which the head is passed and which hangs loosely from the neck to a point well below the knee. A favorite material for the kaftan is the thick stout cotton cloth woven in the native looms to be seen in most of the Mandingo towns. It is usually striped, dark blue and white. Many of the Mandingoes, however, who come from over the border of French Guinea have this kaftan made of velvet or even of cheap silk. On ceremonial and other special occasions, the superior men among them wear sandals made of wood, or more rarely of leather, with thongs of dyed leather or woven grass which are passed over the instep and on the inner side of the great toe. One sometimes sees them when they are on the march, carrying their shoes in their hands. A few of the Mandingo chiefs wear high leather boots. The favorite head covering is a round, tight-fitting cap or fez. The men sometimes wear anklets and always one or more finger rings. Sometimes several amulets are worn and a necklace or two of beads. A few carry either a small whip of leather as a symbol of authority, or more rarely a short straight sword in a leather scabbard.

The Mandingo women are more decorous in their appearance and in their dances than the women of other Liberian tribes. They wear more clothing, but seldom covering for their feet. They are rarely seen nude to the waist, but usually wear a shirt, a loose cloth pulled over the shoulders and a long, loose skirt consisting of a piece of cloth of great width wound several times around the body and girdled at the waist. Round the head a bright-colored cloth in the form of a turban is worn. The Mandingo women are delivered in their houses, and do not go out for seven days after childbirth.

As a people they seem fond of music, and although they have no conception of true music and no scale, they like to make musical sounds on their most primitive instruments, one of which consists of a form of harp with half a dozen fiber strings which they pluck back and forth continuously, always sounding the same notes on the open strings. It has a calabash below the strings, which serves as a sounding board. Flutes are sometimes used, and rattles filled with seeds are shaken, particularly during dances. The Mandingoes also make a crude xylophone of slabs of resonant wood and, in addition to the rattles, small drums are used to accompany dancing.

They are a proud people, who regard themselves as superior to the other tribes of Liberia. Many of them can read the Koran and sometimes attempt to teach Mohammedanism to the other tribes among whom they often make easy proselytes. Although they are usually courteous to white people and ingratiating, one does not gain the impression from being among them that they are always trustworthy. They are quick to take advantage of their intelligence, both in trading and in their other dealings with the members of different tribes. A number of them have small groups of slaves which they sometimes employ either as farm laborers, or as porters in carrying about their produce. It has been predicted that they will make their influence greatly felt in the destinies of Liberia. The writer, however, believes that as the country becomes more civilized, their influence will decline.

Another tribe, the Vais, for the most part reside in western Liberia in the coastal regions between the rivers Mano and St. Paul. When the Portuguese first reached Liberia in the fifteenth century they seem to have found the Vai people already established about Cape Mount. In former times this tribe carried on an extensive trade in slaves. The relationship between the Vais and the Mandingoes has already been discussed. The Vais are usually the best liked, by Europeans, of all the Liberian tribes, and are perhaps the most interesting. They are superior intellectually, are one of the most progressive groups in the native population, and they have been regarded as constituting an important civilized and civilizing element in Liberia. The great majority of them have adopted Mohammedanism, and a number of their learned men can read and write Arabic, which they sometimes teach to the other native tribes. The Vai tribe is the only one in Liberia which has its own alphabet and system of writing. A number of them have recently become Christians.

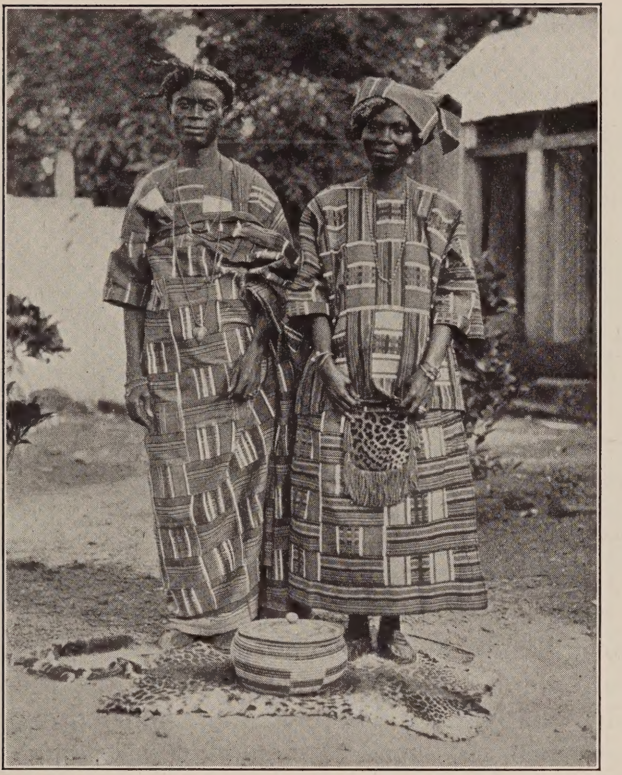
The color of their skin ranges from golden yellow or sometimes an almost olive tint, to a golden brown. The women are good-natured and picturesque at times, and in appearance they are perhaps the most attractive women in Africa (No. 36).

The men are usually peaceful and willing. The Vais today engage in some farming and in trading, and build good villages. They also weave well and make much cotton cloth which, as a rule, they dye either blue or brown. This cloth constitutes an important article of native trade. They make trustworthy servants or porters, guides, and house boys. Our head boys on the march were usually Vais.

On state occasions the Vai men sometimes wear a kaftan like the Mandingo. More often they wear a shirt-like garment of white calico, the tails of which descend to the knee, and which is buttoned over the right shoulder. Often the bosom of the shirt is somewhat embroidered. Beneath it may be worn a cotton singlet and a pair of white calico drawers or trousers.

In their own villages the women are usually nude to the waist. A loose cloth of cotton or velveteen, often of bright color, is generally thrown over their shoulders. A long cotton or calico skirt secured by winding at the waist is also worn. As a rule the Vai women wear no covering over the feet, but they often wear anklets and particularly bracelets and rings. Silver ornaments and pins are usually worn in the hair as well as necklaces of beads. They also weave baskets of beads.

The Vais, like the Mandingoes, practice circumcision, but the Vai men usu-



No. 33. — Plenyono Wolo, son of Vai chief, and his wife

No. 34. — Group of superior and educated Vai people

ally do not tattoo or cicatrize. On the other hand, the women almost invariably do. Cicatrization is done generally when just before puberty they pass through the grigri or sande bush school of initiation. The region scarified is generally the back, chiefly over the loins. The pattern most frequently employed is diamond-shaped, or sometimes two partly overlapping triangles are outlined. As no pigment is used, the result is that raised scars of normal-colored skin are formed. The women often decorate themselves with brown, gray, or white earth, usually some form of kaolin, at other times they use stripes of indigo for adornment. The indigo is used particularly at the time of initiation in the bush school. They often cover their bodies and their faces with whitish clay which gives them a hideous appearance, but which they apparently seem to think beautifies them.

The Vai houses are usually round and plastered with clay. Both the Vais and Mandingoes use beds, generally made of palm mid-ribs closely placed longitudinally side by side and fastened to a wooden frame with short legs.

It has been suggested that the Vai language will probably become the dominant form of native speech in Liberia.[1] However the mastery of the Vai alphabet and writing is a much more difficult feat than learning the language, for the characters are complicated and very hard to remember. The alphabet and the system of writing are said to have been originally devised by a member of the tribe named Doala Bukere. It contains one hundred and thirty odd characters, which represent the sound of a vowel pronounced with one or more consonants, and, unlike most oriental systems, is written from left to right. Although many of the Vais are very proud of this writing and greatly like to practice it, it is not likely long to survive in use for the reasons already given. Some of our Vai servants always kept our lists of laundry in Vai writing.

It is interesting to note that in reference to his visit in 1849 to Doala Bukere, originator of the Vai alphabet, the celebrated missionary philologist, Koelle, alludes to him as a victim of sleeping sickness and says that when he again went to see him in 1850 he found that he had died of a cutaneous disease called in the Vai language "konje-kira" or "ball sickness" (perhaps so-called with reference to enlarged lymph glands) which produced in him such extraordinary drowsiness that he often fell asleep while taking his meals.

The Vais have a number of folklore stories. They also have their medicine men and women who claim special knowledge of the virtues of leaves, roots, barks, and seeds. The medicine men at times practice divination by sand sifting, that is, sprinkling the sand and drawing some deduction from the figures it assumes. They also practice a kind of hypnotism and throw themselves into trances. They believe in the efficacy of sacrifice called "Sadaka" and think that the spirits of the deceased can be attracted to the living in dreams by making some such sacrifice as a handful of beads or a strip of cloth, or by an offering of food or drink. A leopard's tooth is an object of great reverence and good omen. The Vais, like all the tribes of Liberia, believe in the efficacy of the trial by ordeal for the discovery of guilt. Although they are Mohammedans and more educated,

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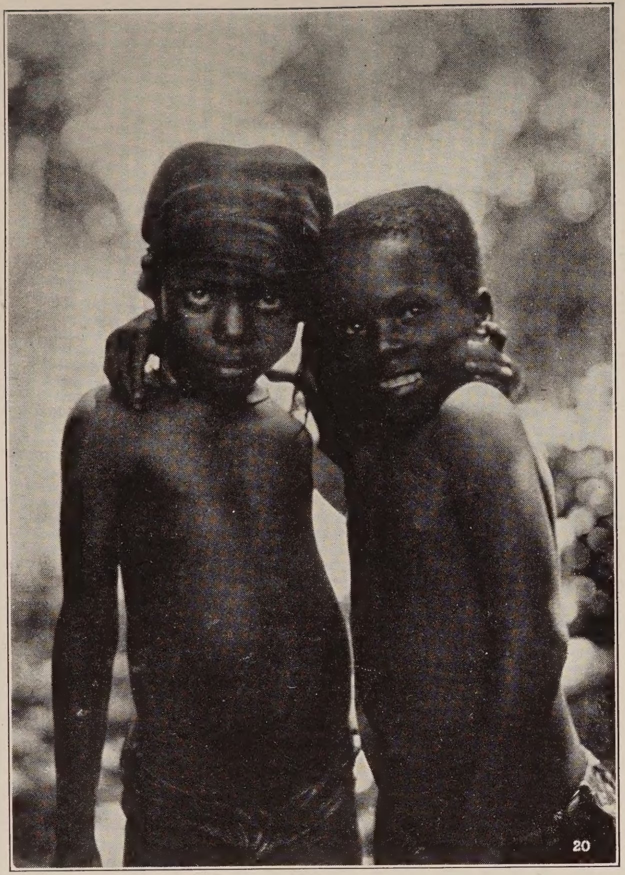
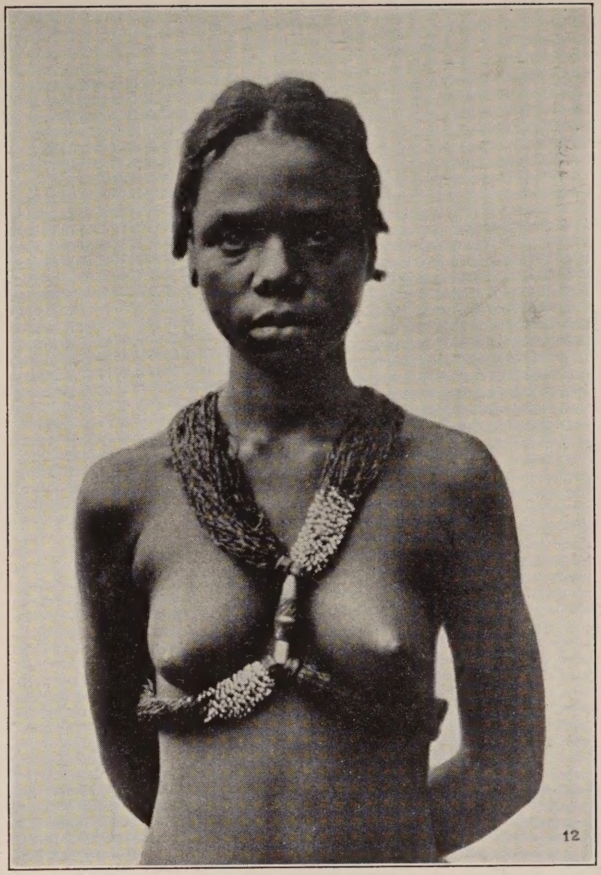
[1] Johnston: *Loc. cit.*, II, 1107.



No. 35. — Vai children



No. 36. — Vai woman

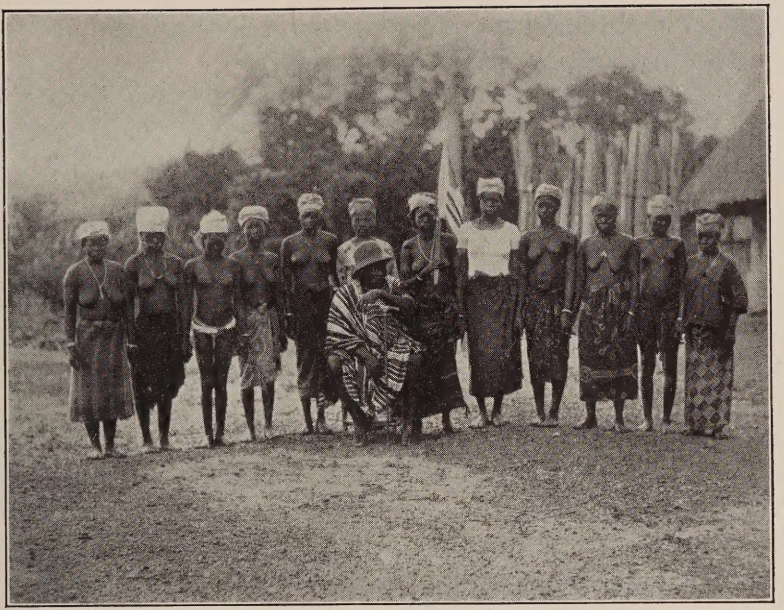
the Vais still maintain their own devils and their separate forest schools for girls and boys known in the Vai language as Sande and Beri respectively. The women's devil is called Femba or Sande-Nyana, the men's is Beri-Nyana. The activities of these bush schools will be discussed later in connection with life in the interior of the country.

The Kpwesis (Kpwessi, Kpelle), who form the largest tribe in Liberia, live in the central region of the country, reaching roughly from the St. John to the St. Paul River. In some sections they and the tribes related to them extend up to the borders of French Guinea and the Ivory Coast. They therefore occupy territory to the north of the Bassas and Gibis, and to the east of the Gola tribe. To the northwest they pass imperceptibly into the Buzi people or tribe, and into the east and northeast they reach the territory of the Jarquellis, the Manos, and the Gios. They seem to have been settled for a long time upon Liberian soil and to be aboriginal in their characteristics. They have been under the supervision of the Liberian Government for at least fourteen years, and they apparently have always been comparatively peaceful and industrious. Formerly they were said to be the principal purveyors of slaves in Liberia.

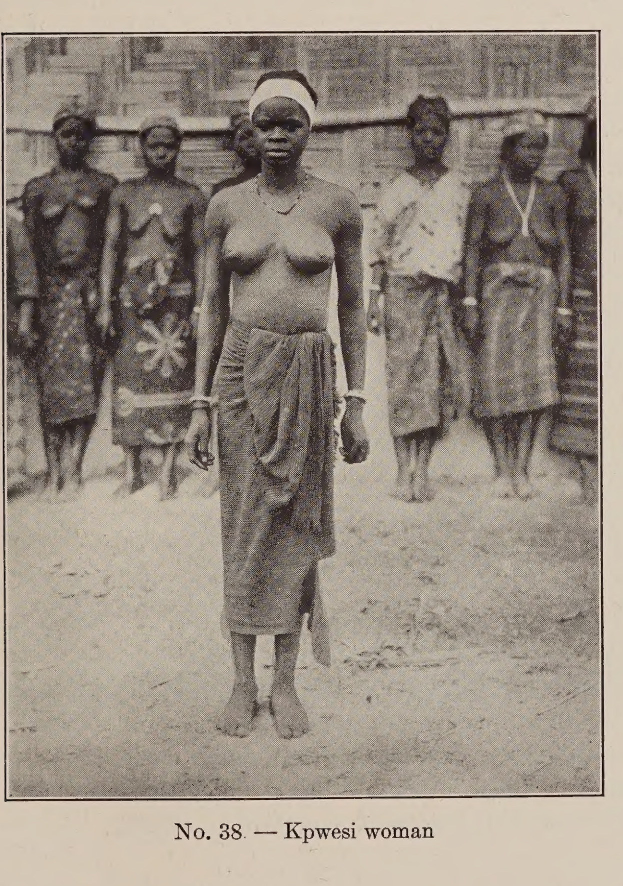
In color they are in general distinctly lighter than the Krus and Bassas, often a yellow or golden brown. They are of moderate height, their arms and legs are not to any striking extent disproportionately long or short, and they are less prognathous than the Krus. In some the facial features are more or less refined. The hair on the head of the women is moderately long and worn naturally, without elaborate coiffure.

The costume of the women consists of an oblong piece of striped cloth which is wrapped round the body just above the hips and below the navel (No. 39). The young unmarried women and young girls often wear only a narrow girdle of white shells strung on a belt of grass or rattan fiber to which a loin cloth is attached. It is the fashion for the women to paint themselves with indigo dye in symmetrical straight lines about a quarter of an inch in width. Thus, one woman will have a straight line down her forehead, and several parallel lines on both cheeks; another will have an oblong pattern on her chest, or lines like shoulder straps extending from the waist behind over the shoulders and down to the nipples of the breasts; still another will paint lines extending from the sides of the neck down the shoulders and arms. In other instances they smear their faces and the upper part of the body with white clay resembling pipe clay, which is said to be both for adornment and to soften the skin. They do not practice tattooing. Both the men and the women practice cicatrization, the women most commonly on the loins, but occasionally on the chest and abdomen. They often wear silver armlets and anklets, usually made of round bands of silver one-half inch in diameter, but occasionally of bands of brass, from one to two inches in width.

The young boys wear no clothing, but the older ones usually have a loin cloth. Although on the march the adult men frequently wear only a loin cloth, in the villages they may wear short trunks or trousers. In those towns where there has been most communication with the coast, both men and women



No. 37. — Kpwesi chief with some of his favored wives



No. 38. — Kpwesi woman

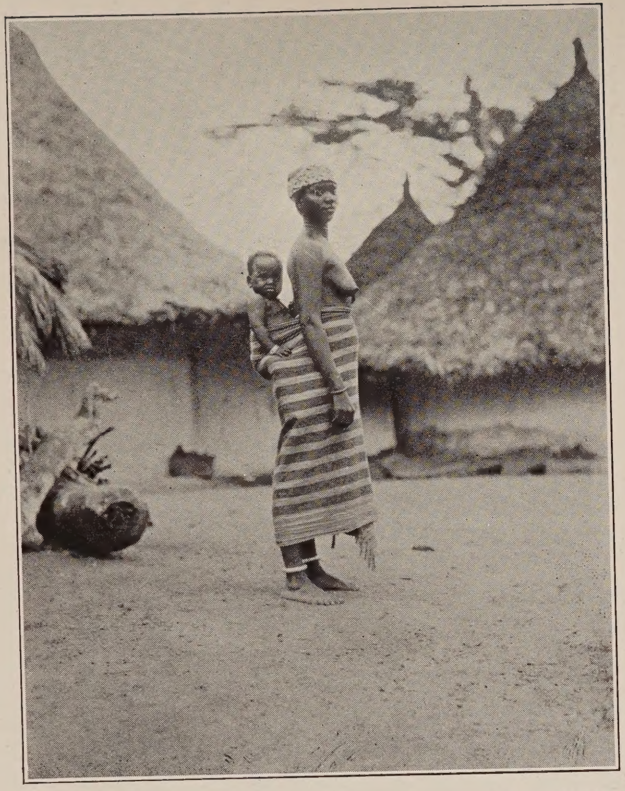
occasionally wear cast-off American or European clothing and the women are frequently clothed in a man's singlet or undershirt.

Their villages vary greatly in size from a dozen or two houses to several hundred. The larger houses are frequently built near rivers or streams, on elevated plains from which the neighboring forest is cleared off so that the land can be used for farming. Many of the villages, particularly the smaller ones, are stockaded. Around some of the smaller villages the stockade, some six to eight feet high, is formed of small stakes driven into the ground placed close, and thoroughly laced together with rattan fiber and lianas. There are usually two gates, one in front used as an entrance and one at the back of the village used as an exit. Around some of the larger villages, the stockade near the entrance consists of poles from twelve to fifteen feet high, closely placed and rammed into the ground. They often take root and, being interlaced with rattan fiber and interspersed with thorny bushes, form an impenetrable wall; in other places masses of thorny bush protect the town where it is not surrounded by the denser forest. Across the trail at the entrance to the town there is often a narrow gate made of heavy slabs of wood cut from the trunk of the silk cotton tree.

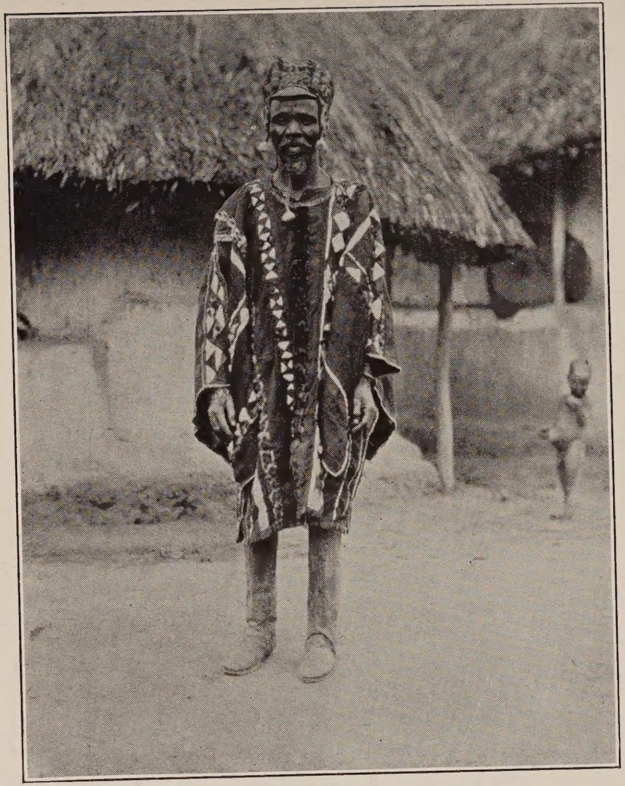
The Chief of the village may also have his own compound stockaded in which he lives with his wives and retainers. The houses are usually of one type and are placed close together. The base is first built of clay and is from eighteen to twenty-four inches high. Around it the poles for the framework of the house are erected. The low walls are then constructed of pounded clay or earth. A framework of slender poles forms the roof. The roofs are thatched and are detachable and thus they can be moved, if advisable, to a new base. Usually, but not always, there is one window closed by a thatched blind, and there is a door of wood closed at night by a latch string. Most of the houses are built with an earthen ledge inside, which serves as a bench by day and as a bed at night. Commonly there is but one room.

Each village has at its center a community meeting place or palaver house, considerably larger than the other houses. It is generally oblong or square in shape; though in rare instances it is oval. The walls are about three feet high, constructed of clay, and inside there is a wide clay ledge and a fireplace. The roof consists of thatched palm, projecting over the clay base for several feet, and serves as a protection from rain. The sides of the houses above the three-foot wall are open, and there is good ventilation. We often slept in these community houses when we were without tents. Occasionally they contained one or two stools, or clumsy chairs.

As a rule, there is no ornamentation of the houses. They contain little but a mat or two, a few boxes and household utensils, and three upright stones on which stands a cooking pot. There is no place in the dwelling houses through which smoke can escape but none of the natives seem to mind the dense clouds that arise from the fire of sticks and logs often green or damp. The rafters, and indeed the whole interior of the house, are usually well blackened. The people themselves frequently show a chronic injection of the vessels of the conjunctiva which may result from this frequent exposure to smoke.



No. 39. — Kpwesi woman showing costume and method of carrying infant



No. 40. — Kpwesi chief Reppo of Reppo's Town

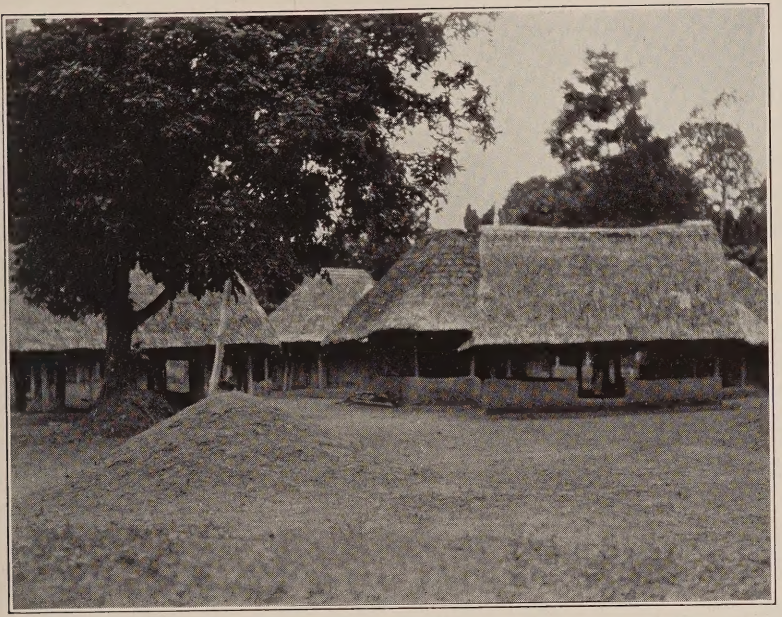
The villages are usually well kept and swept clean. The Kpwesis cultivate the soil, and have farms in the vicinity of their villages, on which they generally raise rice, cassava, and millet, plantains and sugar cane, and also some bananas, coffee, cotton, and tobacco, though usually only in sufficient quantities for their own needs. Formerly they used to smelt the iron for their own spearheads and knives. Iron work is still occasionally done, a termitary of the white ants is sometimes used as a furnace and a shed constructed beside it. Now most of their iron implements are obtained by trading, or otherwise, through the coast tribes.

Among the industries of the men is the construction of big wooden mortars in which the women pound rice. They also carve wooden spoons and gourds for dishes and cups, and drums and musical instruments and pipes.

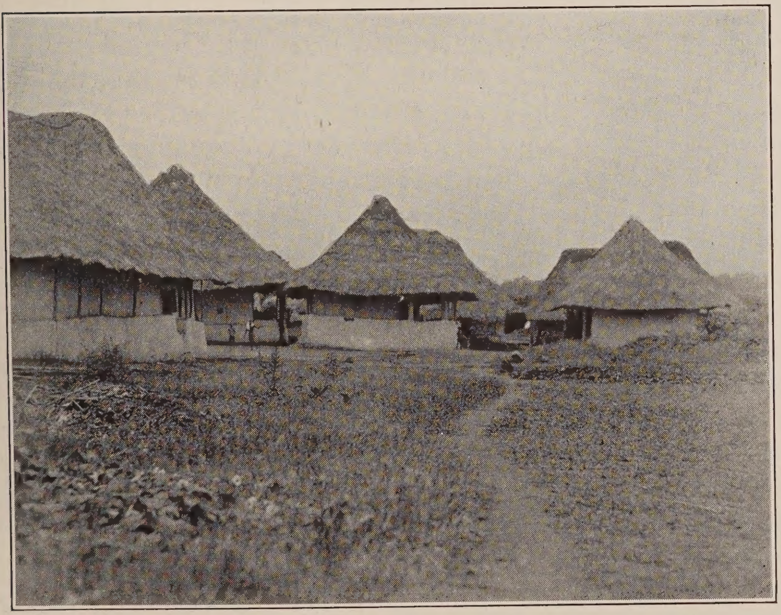
The men also do some leather work, making scabbards for knives and swords, and belts, but are not as skillful as the Mandingoes at this work. They do considerable weaving of cloth but the cotton is raised and the thread spun by the women. When the cotton is ripe they pick out the seeds by hand and after carding it, spin it also (No. 94). The spinner winds a small amount of cotton on a bit of rounded stick which she then holds high in the left hand, while with a twisting and turning motion of her right hand she spins and winds the thread on another rounded stick which has a circular disk of clay at its base. The thread is later often dyed blue with indigo, or red with camwood. The women also weave mats and baskets for rice out of the strands of the raffia palm which, like the cotton, they often dye. As a usual thing, they also make the pots and pans and other clay cooking utensils.

The tribes in the northwest breed some horses, which, however, are very rarely found in the central part of the country. In a few of the larger villages we would occasionally encounter a horse. Cattle, however, are bred with greater success, though only in small numbers; they are nowhere plentiful. The Kpwesis do some hunting, generally using their own knives, but occasionally employing bows and arrows. Now and then one of them is armed with an old-fashioned cap and powder gun. They shoot or capture monkeys, forest buffaloes, duikers, and on rare occasions an elephant. We employed some of the Kpwesis as collectors, especially for obtaining smaller animals for our zoological collections, since they are much more successful in approaching and obtaining animals in the Liberian forest than white men.

Their musical instruments are very crude. The most common one consists of from five to seven fiber strings, strung along a narrow oblong piece of wood over a low bridge. There is apparently no fixed method of tuning. Much like the Vais they pluck the open strings over and over in sequence, and do this as they walk about, sometimes for a quarter or a half hour at a time. They also have an hourglass-shaped drum sometimes with metal disks at the side, like a tambourine. In addition, they employ a rattle made of a gourd which makes a disagreeable noise when shaken (Nos. 46 and 82). When dancing is going on, the musicians make a frantic attempt to keep time with their bodies in the rhythm of the drums. Besides the usual form of native drums, the Jarquellis (a tribe of the Kpwesis) have a curious drum consisting of three large gourds which are



No. 41. — Kpwesi village, vicinity of Farmington River



No. 42. — Kaka Town

struck as they float in a vessel containing water. In one of the Kpwesi's villages we found an entertainer who amused the natives by making curious noises and in some instances imitated the cries of animals and birds.

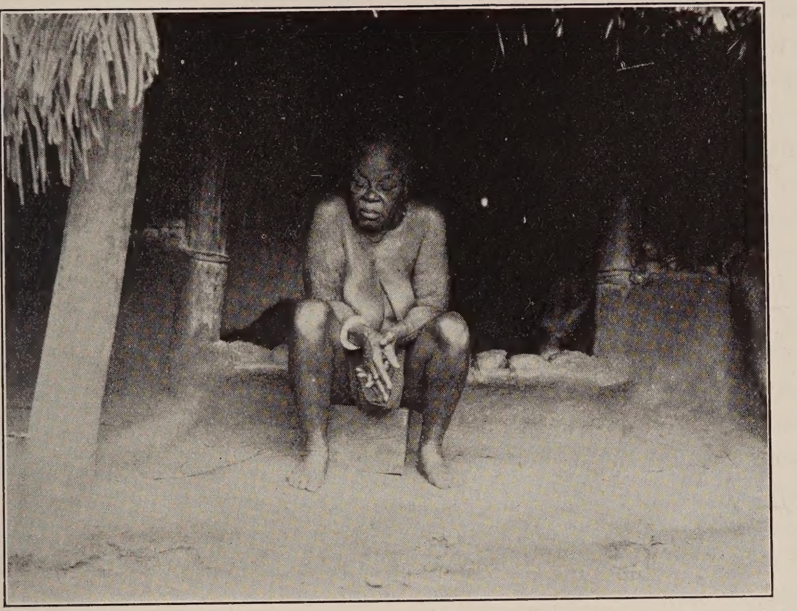
As is the case with all the interior tribes, dancing is one of their chief forms of amusement. The dances sometimes occur in the late afternoon, but frequently after sunset when they usually last throughout the night, in which case a large wood fire is kept burning in the bush clearing or compound before the Chief's house. Great throngs of onlookers crowd round the quadrangle where the dancers perform. Every movement of the dancing is regulated by and in time with the beat of the drums. The drummers are in general exceedingly skillful and the very great variety of rhythm as well as of the tempo cannot fail to elicit intense interest and admiration. The dancers also usually display considerable ability and the most celebrated ones are evidently kept in splendid physical condition. The most striking dancing is done by individuals dancing alone. Other dances are performed in groups but not in couples.

There is a large number of children in most villages. In some of the smaller villages at least there are many more women than men. In Lenga Town, in sixteen houses we found one chief and an assistant, all the remaining inmates were women or children, about thirty of them in all.

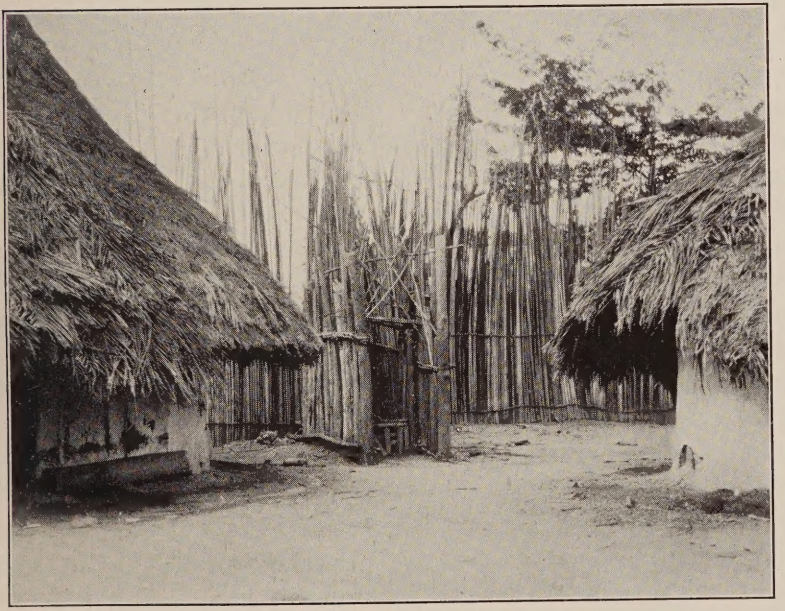
Polygamy is practically universal, as it is with the other interior tribes. Some of the Kpwesi chiefs have from thirty to forty wives, and sometimes, though rarely, more than a hundred. The wives furnish a ready supply of labor with which to carry on the agricultural work, for the women do all the farm work after the land has been cleared of forest trees. After buying a wife, the Chief presents her with a farm. The produce which she must raise belongs to him. After the child is born the mother lives apart from her husband until it is weaned, a period of from eighteen months to two years. One village Chief brought his last new wife, a girl of apparently some fifteen years, for treatment of a tropical ulcer on her ankle; she promptly kicked over the bucket of bichloride solution with which her leg was being bathed (very much as a cow might kick over a pail when being milked), and ran away.

Most of the tribes in Liberia regard twin children with suspicion, and it is said that among the Krus if one twin is a male child it is sometimes destroyed. Among the Kpwesis, however, twins are supposed to possess peculiar powers, and when they travel to different villages they are often presented with special but always identical presents.

The power of the chiefs seems to be great in their own villages, and almost absolute with their subjects, though the Liberian Government, by a series of regulations, has attempted to restrict greatly, this power. The Kpwesi tribe and the large number of tribes related to it carry on the training of the young unmarried members of the tribe in their bush schools. They are exceedingly curious people; everything that we did they watched with the closest attention. The tribes in the center of Liberia, however, did not seem to be nearly so superstitious as some of the related ones who live in the eastern portions of the country and who will be more particularly referred to later.



No. 43. — Suahkoko, ruler of town of that name



No. 44. — Stockaded entrance to residence of Suahkoko

The dialects of the Kpwesi tribes show a decided affinity with the Mandingo group of dialects. Johnston says that if these resemblances are real, they are undoubtedly due to the fact that the Kpwesi language is derived from a very ancient West African mother speech. The Kpwesi or Kpelle language, which is most widely employed in Central Liberia, has been especially studied and reduced to writing by Westermann.[1] Varying dialects of it are spoken by the tribes which surround the central Kpwesi group just discussed.

The many invasions of Liberia and migrations into it, and the interbreeding of different tribes of people, have left a variety of groups speaking more or less different dialects, and varying more or less in their customs, habits, and industries. Thus like the name "Kru" the name of "Kpwesi," "Kpelle," or "Gbele" has been used to designate a group of related tribes. The Kpwesi's country is divided into a number of different independent domains or kingdoms that contain a varying number of villages. In some of them the same dialect is spoken, in others the dialects are considerably varied. In all the different districts, however, the local ruler is known as the Paramount Chief. Each domain or kingdom also has a chief town, with a ruler whom it is rather absurd to call either a queen or a king as is sometimes done. The town of Suahkoko is presided over by a woman (the queen) of the same name. She is a woman of advancing years, with gray hair and failing eyesight. Nevertheless, she displays surprising intelligence in her conversation and is apparently feared, respected, and obeyed in her community. She lives near the center of the town, in a stockaded compound which is entered through a narrow passage, the walls of which are made of heavy stakes, and which has a heavy wooden door at each end. Within the compound there are five houses which she occupies with her relatives and dependents. She received us sitting upon a small stool, wearing practically no clothing (No. 43), and through an interpreter told us that her five sons and two daughters were dead, and that she was assisted in ruling by one grandson, a man apparently between twenty-five and thirty years of age. She also stated that she was the only chief in the vicinity to take the side of the Americo-Liberian Government in the hostilities that occurred several years ago in connection with the refusal of some tribes to pay the hut taxes. Her province was apparently well governed, and all the promises which she made while we were in the community, and in response to our requests, chiefly relating to the sale of food, to transportation, and the examination of her people, were kept.

In the region around Gbanga where the farms are most numerous and where agriculture and the weekly market day play an important rôle in the life of the people, the tribe known as the Jarquellis reside. In their general habits and customs they resemble the Kpwesis. Apparently, however, they are a somewhat more savage race. The men frequently file their teeth to long points; and the women more commonly, and certainly more conspicuously, practice cicatrization, in diamond-shaped patterns on their abdomens and breasts (No. 47). The Chief of Gbanga evidently assumed a dictatorial authority over his people.

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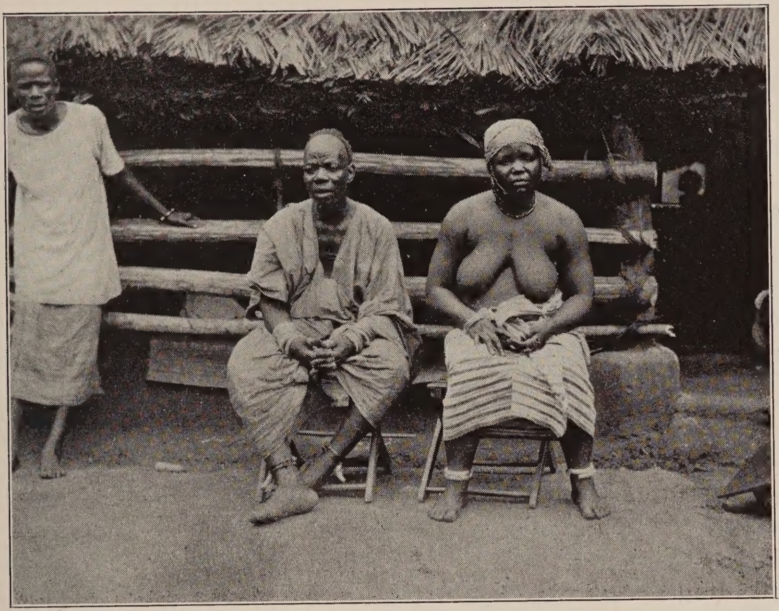
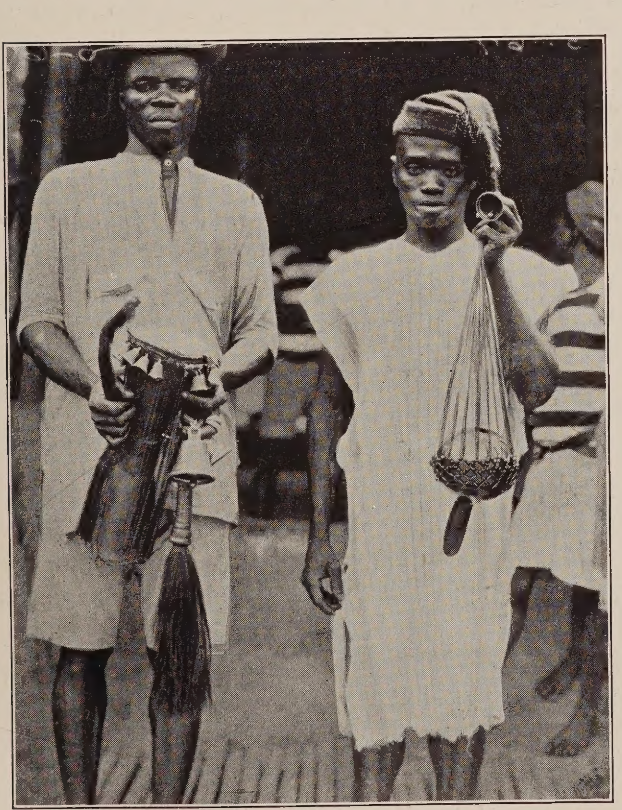
[1] Westermann: "Die Kpelle, ein Negerstamm in Liberia," Göttingen, 1921; and "The Kpelle Language in Liberia" (with H. L. Melzian), Berlin, 1930; in cooperation with the Firestone Plantations Company and the American Advisory Committee on Education in Liberia.



No. 45. — Jarquellis chief and head wife



No. 46. — Musical instruments of Jarquellis

There the *pawning of women* was particularly brought to our attention. A man in Liberia may pawn as security for a loan of any kind, almost anything he possesses, including his wives or dependents, for any amount that he can get for them. However, the Liberian Government regulations on the subject provide that the person concerned must give his consent, a provision that is obviously disregarded for the most part. In order to differentiate the act of pawning an individual from slave dealing, it is stated that the pawn must be accompanied by some token, such as a ring, a bracelet, or other possession. Inanimate articles pawned may be used by the holder of the pawn, and if clothing, may be worn. In the case of a woman, the holder of the pawn acquires all rights over her person, and according to the regulations can "take her to wife until redeemed." [1] If she bears him a child, he may retain it if he wishes.

In 1923 the Liberian Government in attempting to control further this system of pawning in the hinterland, provided that pawns should be allowed to redeem themselves (which, clearly they can almost never do), and that a pawn should be redeemed by the payment of the original sum and nothing more. The regulations also forbade the pawning of Liberians to foreign subjects. Obviously foreign subjects do not reside in the interior of Liberia, but only in Monrovia and in the coast cities, and this provision discriminating as it were against foreign subjects, brings clearly to mind what may be referred to as the "white slave" traffic in Monrovia, if we understand that the word "native" is to be substituted for the word "white."

With reference to the custom of pawning children, or of receiving children to be educated or to be employed in domestic service by the civilized people living on the coast, Buell [2] says:

"Practically every negro family in Monrovia and other coast towns has such children in its household. Often such children stay in their new family for a period of ten or fifteen years. During this period they are obliged to do the housework and a number, it appears, perform labor on the farms. In some cases such children are mistreated. A prominent Liberian was found guilty of mistreating eight boys who ran away and took refuge with the county attorney. Nevertheless it seems that many of them receive the same kind of education as the colonists' children, and legally they may leave their foster parents and return to the bush when they like. The children frequently marry into the family, in other cases adopted girls become concubines. The Liberian system has given the native children an education which many of them would not have otherwise received, and by injecting new blood into the coastal population, the system is forging a Liberian nation. Nevertheless, there are in any such system certain obvious abuses which should if possible be prevented by law. Every family accepting such children should be obliged to assume the obligation of a guardian enforced by the courts. There would seem to be stronger reasons for enforcing a rule prohibiting pawning against the "civilized" Liberians who profess a high standard of ethics than against the aboriginal tribes."

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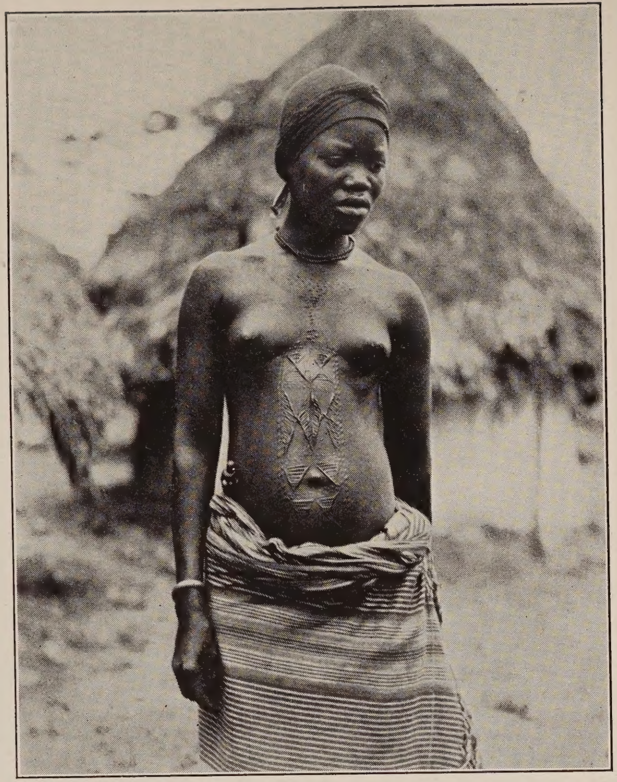
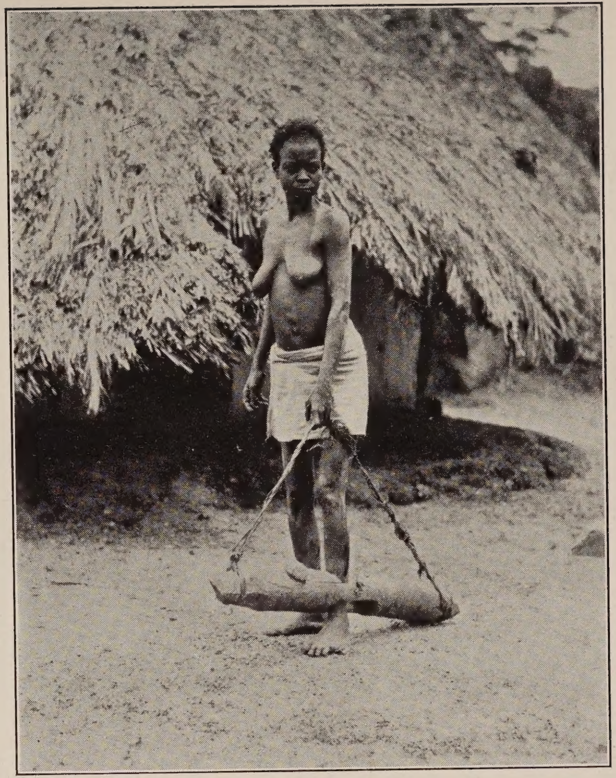
[1] Liberian Department Regulations (1923), Article 19.

[2] Buell: *Loc. cit.*, II, 750.



No. 47. — Cicatrization of chest and abdomen



No. 48. — Woman in pawn

In the interior, among the more savage people, one has opportunity of witnessing at least some instances of the harsher treatment of pawned women.

In No. 48 is illustrated a young woman pawned by her husband. Not liking her new owner, she is said to have resisted and finally to have tried to escape. She was then chained, her foot being thrust into an opening made by logs riveted together, so heavy that the only way she could move about was by lifting them by means of a liana rope attached, and held in her hand. We found her in the market place being severely bitten by many insects. It was necessary to remonstrate forcibly with the chief of the town in order to obtain better treatment for her.

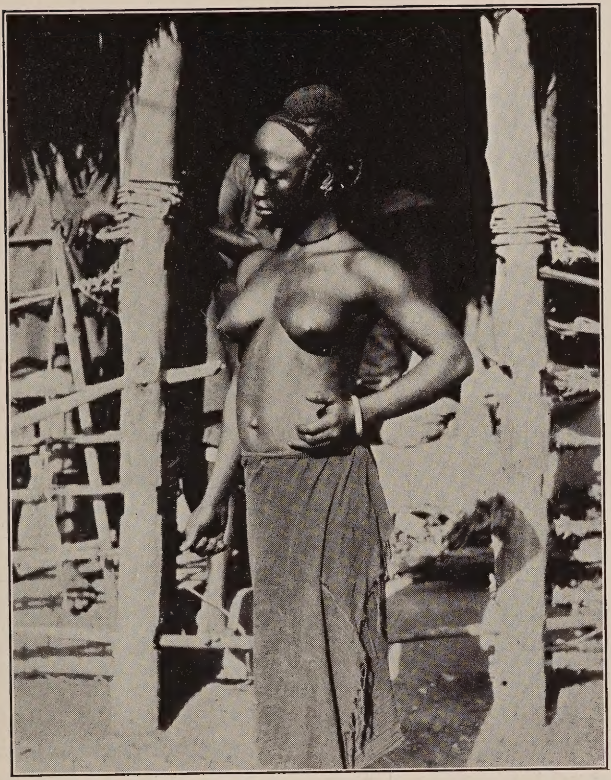
Across the St. John River on the eastern bank one comes into the territory of the Manos, or Mas, another tribe that is related to the Kpwesi but that speaks a different dialect. As there are no canoes on this part of the St. John River, the tribes on the opposite banks have very little communication with one another. Porters are usually not willing to go beyond the limits of the territory occupied by their own tribe, or in any case only so far as the first town beyond their own boundaries, from which they can quickly return. In many cases they are evidently afraid to enter the village of another tribe after dark.

Notable among the Mano women is the care often bestowed on the hair and the manner of dressing it, which is illustrated in No 49. The kinky hair is drawn back from the forehead and temples, parted for a short distance from the forehead and thus divided into three sections. A narrow plaited strand over the top of the forehead is visible in front, and the rest is bunched into an oval mass on the top of the head. Pins of soft silver or aluminum are often worn in it. The men usually shave the hair of the head with the exception of the central portion which is allowed to grow to some length, and is often plaited in tight, kinky strands.

Both the men and the women to the east of the St. John River are usually more robust in appearance and taller than those one sees among the central Kpwesi tribe. Both the Manos and the Gios are somewhat similar in their customs, including the manner of dressing the hair. The men frequently wear only a loin cloth or G string and sometimes even go naked as indeed in the smaller villages even the women occasionally do. It also appears that cannibalism has persisted for a longer time among both these tribes than among the others in Liberia. It is among them that one still finds the "leopard men."

The course of initiation in the devil and grigri bush schools among the Manos is said to be very much shorter than among the other tribes, and not to exceed a few months. A much more detailed initiation is necessary among some of the other tribes.

The Gios, who have their own dialect, and who live chiefly to the eastward of the Yaw River (a tributary of the river Cess which we crossed), are even hardier in appearance and are a more energetic people than the other Kpwesi tribes. Some of them are nearly six feet in height. They make excellent porters and laborers, and some of them are good hunters. Their chief town or capital is known as Tappi Town, a village of several hundred well-built houses, having



No. 49. — Woman of Ma tribe, illustrating method of arranging hair

No. 50. — Porters of Ma tribe

tall conical roofs. There is an Americo-Liberian compound outside this village, which is occupied by the government District Commissioner when he is present.

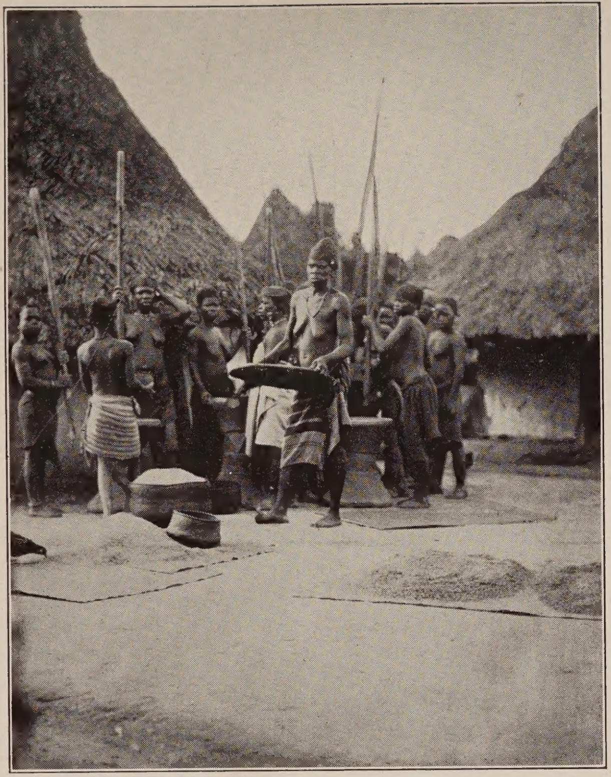
Tappi Town is situated on the summit of a plateau, and to the eastward the country is more open and rolling. There are many farms about this center, and cattle, although still not plentiful, are more numerous. Notwithstanding the good appearance of the village, it became quite obvious after living among the Gios that they are a savage people, superstitious, low and degraded. Like the Mas they also displayed the greatest curiosity about almost everything that we did.

Travelling still farther to the eastward after crossing to the right or north bank of the river Cess, we next encountered the tribe of the Gibis. They are a distinctly more indolent people than the Gios, and very superstitious. Their villages are of poorer appearance. The trails through their country are few and badly kept, and they have very little intercourse with their nearest neighbors, the Manos and Gios. Their physical appearance is also generally much poorer, and there are many undernourished people among them.

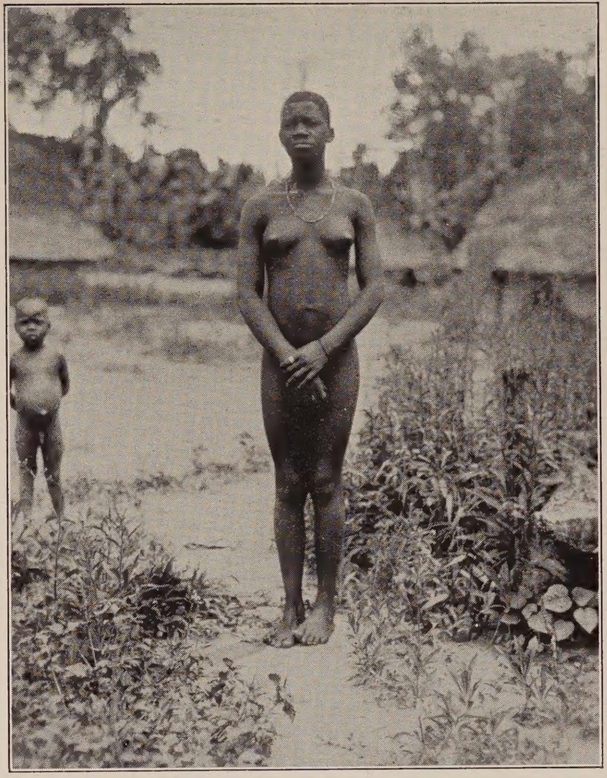
In addition to the larger tribes already referred to, there are a large number of smaller ones. The De people have occupied chiefly the country west of the St. Paul River, to the north of Monrovia, and south of Boporo (Bapore). They have almost disappeared as a distinct tribe. It was with the De and the Mamba tribes that the agents of the American Colonization Society in 1821 carried on negotiations for the ownership of the Mesurado strip of coastline, one hundred and thirty miles long and forty miles broad, which they wished to have reserved for the settlement of American freed slaves. Hostilities soon broke out between the De tribe and the colonists over the occupation of this and the surrounding land. Johnston states that since the war which the De and Gola tribes carried on intermittently from 1838 to 1840, in which the Golas were victorious, the Des have held an inferior position and become a diminishing tribe. They practice cicatrization, but many of their other customs are somewhat similar to those of the Krus, and they speak a related dialect. They are said probably to represent a western extension of the Kru group. The remaining Des are negroid in appearance, but as a rule do not show as marked a tendency to shortness of leg, and the women on the whole have better features than the Kru women. In recent years the Des as a tribe, have been almost absorbed by the Americo-Liberian community. Johnston states that it is a tribal custom among them to extract one or two incisors in the upper jaw, and he gives a photograph of a boy with those teeth missing.

The Gbandi tribe probably sprang from one of the combinations of Mandingoes with stock containing pure negro blood. They are a Mohammedanized tribe and are so closely related to the Vais that they need not be considered separately. As a group, however, they are less civilized than the Vais and formerly were said to be much addicted to cannibalism. They occupy territory to the north of the Vais and extend to the northeastern border of Liberia and into French Guinea.

The Buzi people who also live in the northeastern part of the country be-



No. 51. — Woman preparing rice, Qué-Congo



No. 52. — Gio woman and child

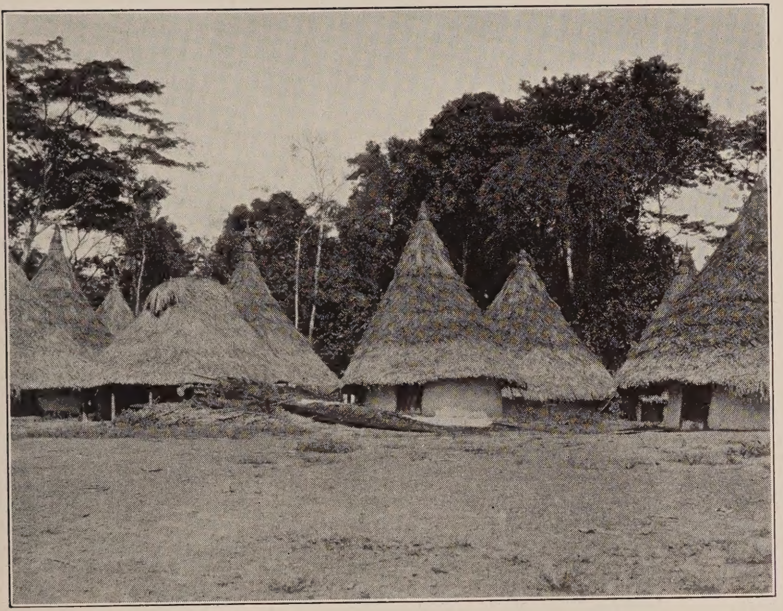
tween the Gbandi and Kpwesi and extend as far east as the St. Paul River, are much more closely related to the Kpwesi tribe of central Liberia than to the Vais, though they have a different dialect and have been said to be more turbulent and quarrelsome. The greater part of this tribe now live across the border in French Guinea.

The Gola tribe is of some interest, since ethnologically it seems to be considerably isolated. Its members dwell chiefly in the basin of the St. Paul River north and west of the Kpwesi. Their language is almost distinct and is probably a direct descendent of the mother tongue of West Africa; it shows no direct relationship in its roots to adjoining forms of African speech, and in its vocabulary has only a slight resemblance here and there to the Kru, Mandingo, and Fula groups, and even to the Bulom dialect. According to Johnston the Golas probably were an invading race, and may be a people of the high Sudan, driven south through the Liberian forests by some race movement, due to conquests. History tells us that they have been a turbulent, aggressive people and sturdy opponents of Liberian rule in the early days, and also of the De and Kpwesi tribes. They are usually somewhat lighter in color than the Krus, but are often of a Sudanese type of countenance, with rather prominent cheek bones, but only occasionally are they somewhat markedly prognathous (No. 55).

In many of their customs they resemble the Kpwesis. Their women, however, cicatrize, usually on the back, in a similar way to the Vais. Many of them are Mohammedans and practice circumcision. The women have hair of moderate length, not markedly kinky, and they usually part it in one or several places. They are inclined to be lazy. A few of the Golas are found cultivating coffee on the small, poorly-kept plantations in the region of Kaka Town. It is said that they hold themselves superior to the Kpwesi tribes, but there is no evidence that they are superior except that they have come more under the civilizing influences of the coast. Formerly they are said to have had many Kpwesi slaves.

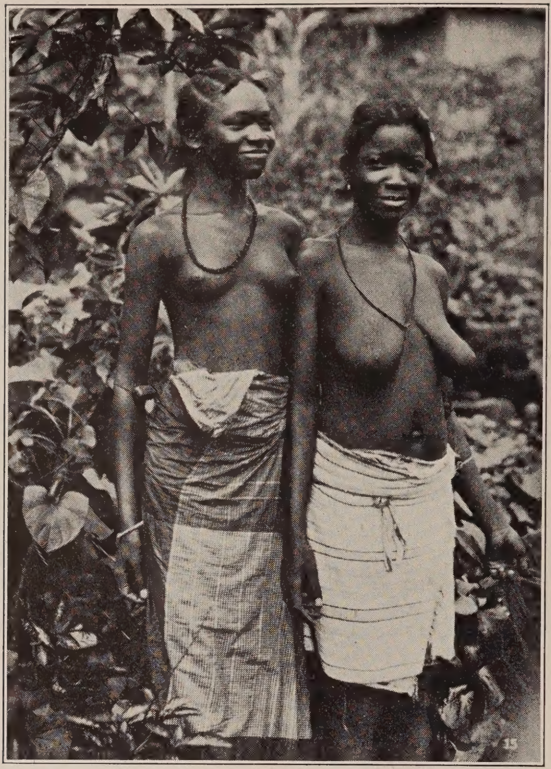
On the edge of the northern border of Liberia, adjoining Sierra Leone, are two tribes known as the Mendis, and the Kissis or Gizis. They apparently stray back and forth along the border in this region. Evidently, they play a part of little importance in Liberia, and the great majority of them, estimated at 25,000, live in Sierra Leone and French Guinea. Johnston believes that in its word roots the speech of the Kissis is related to the Bulom group of languages of southeastern Sierra Leone. However, it has a very different grammatical construction, for its nouns change from singular to plural by alteration of terminals and not as in Bulom by the application of a prefix. Although it has not been carefully studied, Westermann associated it linguistically with the Gola tongue, the characteristic feature of which he believes to be the division of the nouns into classes by means of prefixes and suffixes in a manner analogous to that of the Bantu languages. We observed only a few members of the Kissi and Mendi tribes during our travels in Liberia.

Returning to the eastern part of Liberia, after travelling for several days south from Tappi Town and then on to the coast, we come into territory occupied by a number of smaller tribes, some of which have had exceedingly little



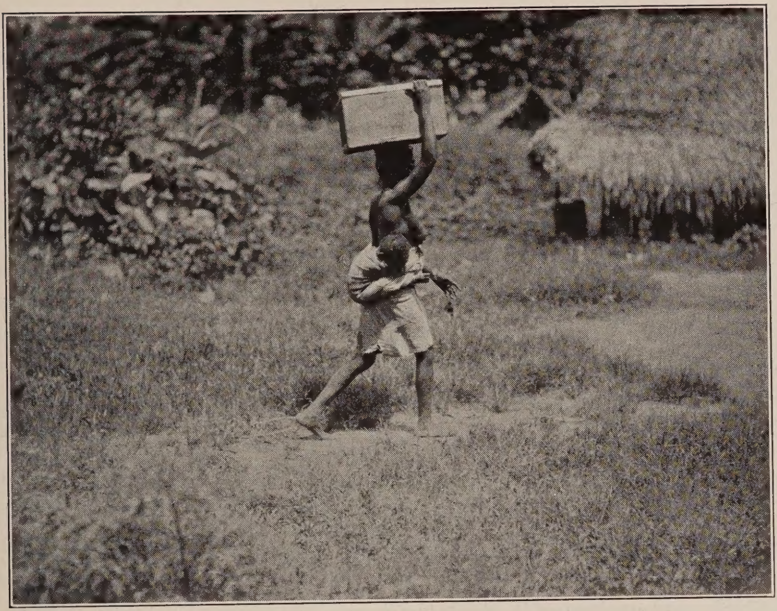
No. 53. — Sessu Town, village of Gios

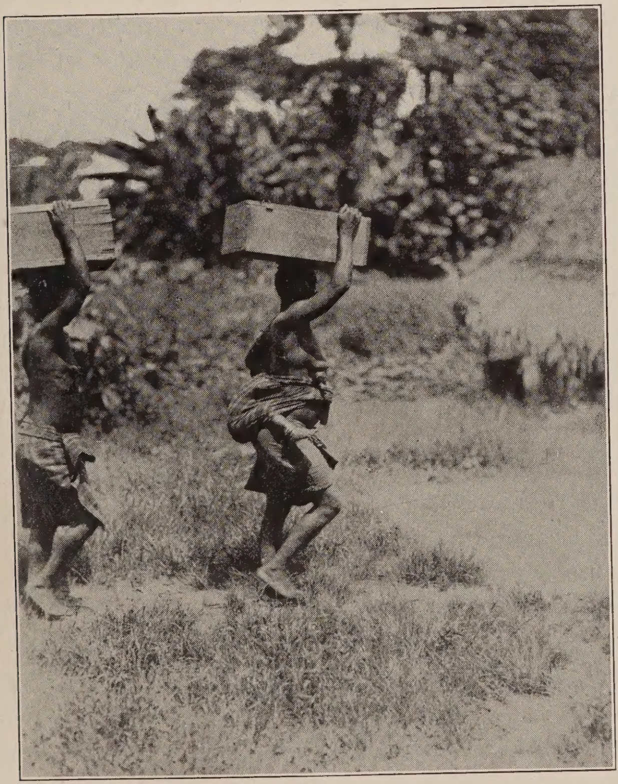
No. 54. — Gibi women



No. 55. — Gola women

No. 56. — Neglected coffee plantations near Kaka Town



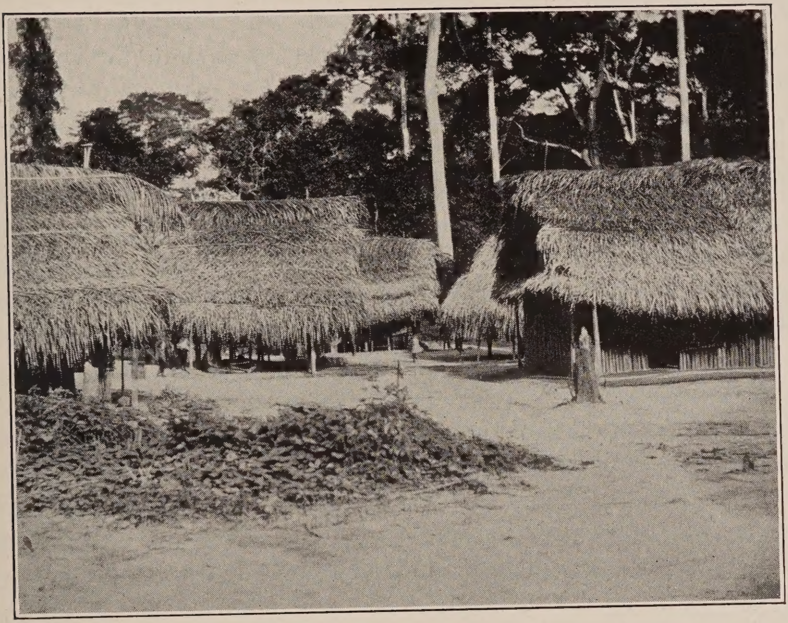


Nos. 57, 58. — Women porters carrying babies, at the head of the safari column communication with civilizing influences. Numbers of these people apparently had not even seen white men before. Apparently no description of these tribes has been published or even written.

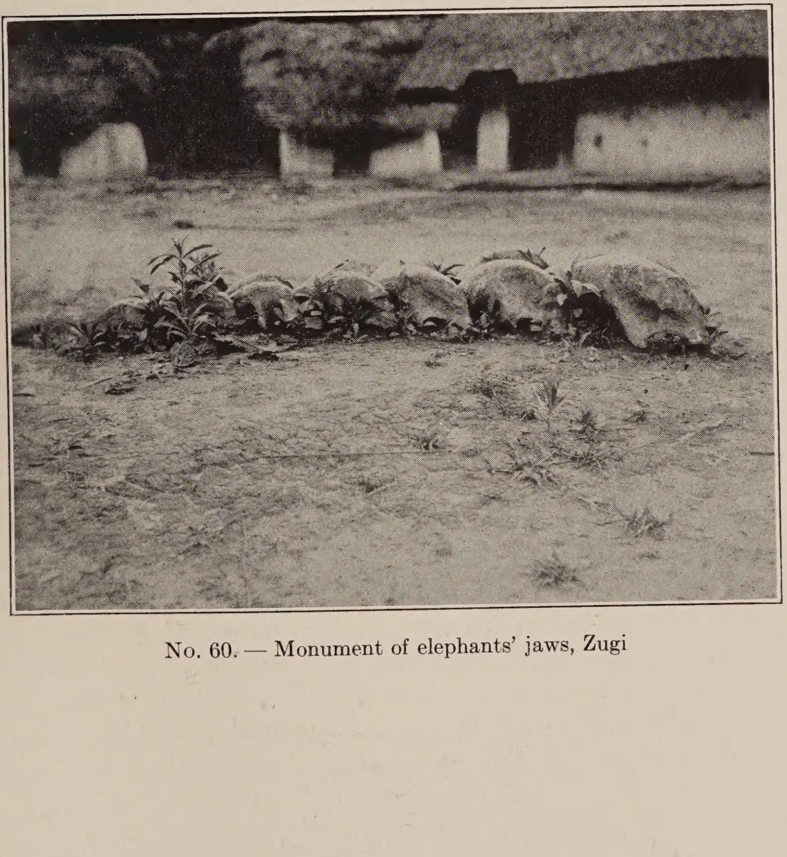
In most parts of Liberia the work of the women seems to be rather well defined. In addition to the pounding of rice, weaving of baskets, etc., and doing the farm work, they carry farm products to market on their heads, but generally they never carry heavy loads on their backs, as for example the kinja or native hamper of rice. They do not act as porters. However, in the remote districts of eastern Liberia, the women in some of the villages even do all the work commonly performed by porters. In some of the more northern of the eastern towns we found very few men, owing to the fact that the District Commissioner had recently visited the town, and the men had either been carried off to act as porters or had run away. This scarcity, however, was probably a more or less temporary matter. But in some of the towns farther south, there seemed to be more women than men in the population, and the women apparently had become the dominating influence in the community. How temporary or permanent this dominance was, we were unable to determine. In the town of Granh, there were only three men and forty or fifty women, and very few children. As a rule the people in many of these eastern towns wore very little clothing, sometimes only a loin cloth made of bark fiber. Many of the women seemed anxious to work as porters and to earn a little silver which some of them had apparently never seen before. They carried their loads as well and quite as cheerfully as the men. Many of them insisted upon carrying their babies on their backs along with the load on their heads. A woman would carry her load several hours, then stop and eat a little mandioca root, nurse the baby, take up her load and go on (No. 57).

The women carried their loads for five or six hours a day very well. Though they sometimes smeared their faces with white earth we did not observe any tattooing or cicatrization among them. In some of the towns there was evidence that, at least in the past, game had been hunted; for the shed under which we lived in one town was lined with clean white skulls of hippopotamuses, bush cows, and elephants. But we saw no skulls recently acquired, with remains of flesh or cartilage upon them. In the center of Zugi Town there was a group of eight skulls and lower jaws of elephants, perhaps a monument of prowess (No. 60). A somewhat similar monument of bones surrounding a group of palms, was seen in Chekomma. A femur of an elephant was also found in this village. In Towya there was a circular plot surrounded by stakes with palm vegetation in the center, around which bones of smaller animals had been placed, and vessels containing food. It evidently was a fetish of the town. In another village there was a fetish pole in the center surrounded by a thatched covering, and containing one or more carved wooden figures about which were a number of vessels holding rice and peppers and similar foodstuffs. Occasionally smaller bits of bone were found in the vessels. Carved wooden masks were occasionally seen in the houses.

As we travelled southward among these tribes, the type of dwelling house gradually changed. In some of the villages, — Weea for example, — we found



No. 59. — Trué Town



No. 60. — Monument of elephants' jaws, Zugi

some of the houses, still with a clay base and walls four feet high, but the great majority of them were built entirely of wood. A number of them were round and had no windows. At Trué Town, no clay was used for the walls. Here the walls were of parallel poles, often of cane, placed upright and close together. In Chekomma, too, clay was not employed in the construction of the houses. Here none were built on the ground but on platforms which stood about three or four feet high, and which consisted of a framework of poles. The houses were not round, but square. The roofs of palm thatch projected over and beyond a veranda or entrance of poles, three feet above the ground. The walls were wattled and the floors made of split rattan. The ceilings were so low that one could not stand upright, in which respect they were like the houses one sees in certain parts of the interior in the Philippine Islands. In the Philippines, however, bamboo is almost exclusively used in construction.

Among these people, locally known as the Kulus, we found some of the best physically developed men in Liberia. They were tall, lithe, strongly-formed, and made excellent porters. When they carried for days at a time in the forest, they would call to one another by baying, as hounds often do. They are a savage people and sometimes would beat their drums furiously throughout the entire night.

Coming still nearer to the coast, among the tribes of the Bo people, we noticed a death ceremony that we had not observed elsewhere in Liberia. Two days after our arrival, a woman died of puerperal septicemia. The women of the village congregated about her house and began to lament and howl loudly. They kept up their lamentations almost continuously for forty-eight hours, when the body was taken for burial to the edge of the village by the forest. It is said that the relatives of the deceased must eat no rice until the next harvest of rice occurs, and that it is customary to give presents to the members of the family of the deceased.

Another custom, said to exist among these people, permits a girl who, as is usual, is betrothed to a man early in life, to take an official lover, if she chooses to do so, up to the time the marriage ceremony actually occurs with the man to whom she has been betrothed earlier in life.

The people in the towns north of Sino or Greenville speak a dialect known either as Sikon or Putu, which, although bearing considerable resemblance to Kru, has certain affinities to Kpwesi and Mandingo. To the north of Sino the Padebu dialect is more commonly spoken.

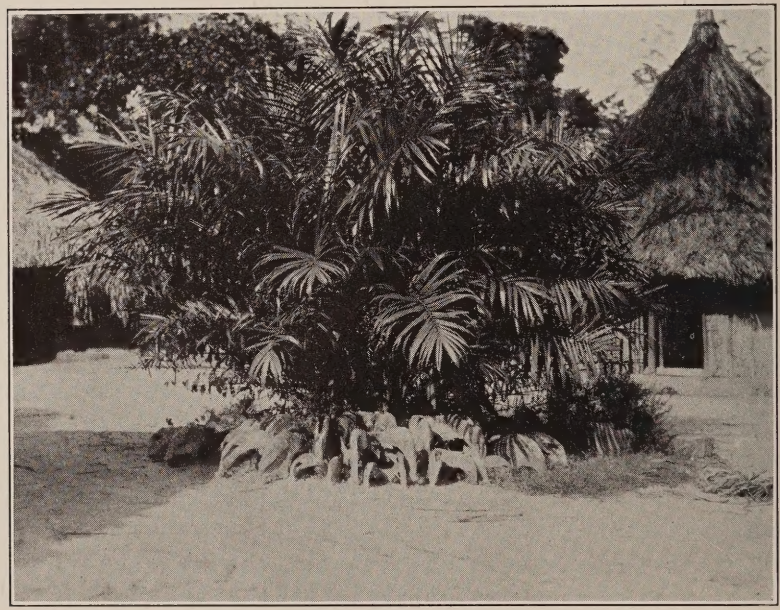
V

TRIBAL CUSTOMS

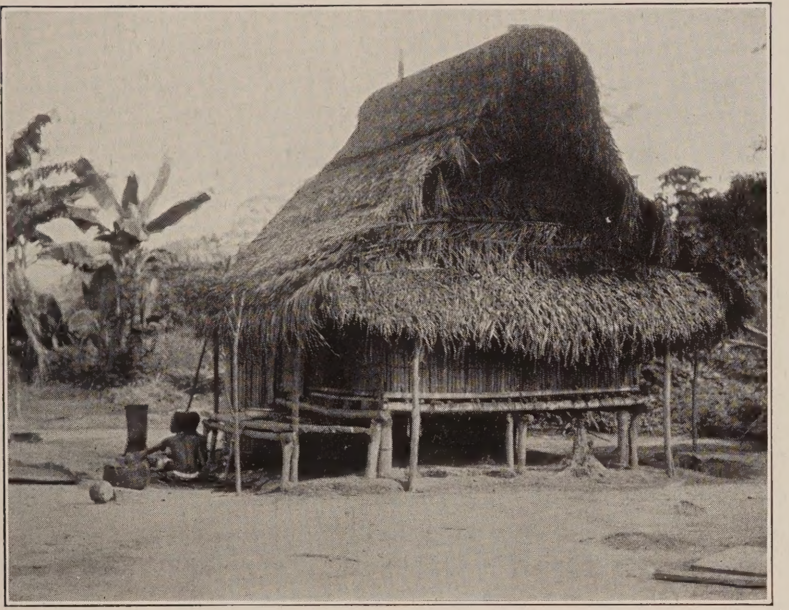
Most of the tribes in Liberia still practice certain ceremonies connected with the initiation of both boys and girls in the bush schools, known commonly as the devil bush for boys and the grigri bush for girls. Locally these schools are designated by different names. Among the Vais the boys' school is called *beri;* among the Krus it is *kedivo;* among the Bassas, Gibis, and Grebos *boriowah,* while among the Kpwesi it is termed *poro.* The corresponding girls' school is known as *sande, bundu, sembe,* or *grigri.* Such bush schools still exist not only in Liberia, but in parts of Sierra Leone, and further south on the west coast, and even in parts of the Congo basin. Great secrecy, feigned or real, is maintained by the native tribes about the organization and customs of these mystic schools, or law-god-purification societies, as they are sometimes termed. When one enquires about them of the natives, he is usually told that their chief function is to change boys into men and girls into women and to teach them tribal customs. It has been presumed that they originally became established to enforce and maintain tribal conditions, customs, and beliefs in danger of changing and becoming obsolete. The school, which is situated in the forest, is often walled off from the trail by a fence of striking form which is constructed of palm trees on the outside and thorn bush within, interspersed with ornamental pillars (No. 65). The trails leading to the bush schools are sometimes closed, a fact which is indicated by bundles of palms or other leaves hung beside or over the trail. The *poro* or presiding official of the society also uses such signs to indicate the entrance to the bush school. Among these signs are a bundle of twigs, a plume, a spiral, and two double pyramids placed point to point. This latter sign is also sometimes seen on the house walls. The spirals, called *dimomoi,* may be of twisted palm or creeper and are usually placed outside the outer gate of the sacred entrance.

The isolation of the bush school is respected by all natives and its inmates are not molested or visited except by those connected with the institution. Beyond this barrier or fence a place is cleared in the forest where the huts for the boys or the girls, and a palaver house and special residences for the devil and his various assistants, are built. Trails are then cut to the nearest creek or river and to farms which are prepared in the vicinity by first cutting down the larger forest trees. In order to enforce respect and regard for the school and to preserve the tribal customs and lore, the native mind has hit upon the idea of a devil presiding over the school, who will frighten the people into discipline and belief. This devil or grand master, *Beri Nyana* of the Vais and Golas, when he goes out of the school or sacred enclosure, *beri-fera,* is accompanied by a number of people called *zo* who encircle him so closely that theoretically he cannot be seen by the un-

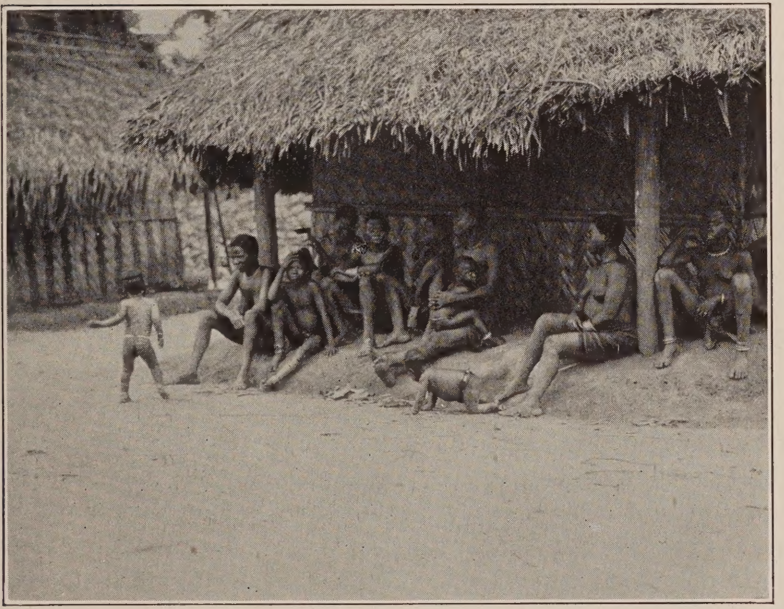
No. 61. — Village of Chekomma



No. 62 — Plot of palms surrounded by bones in center of village



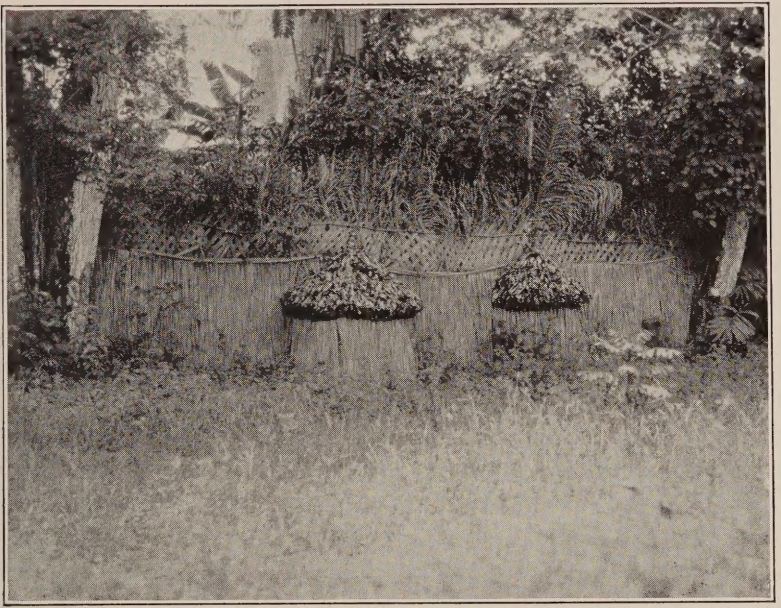
No. 63. — Chekomma, illustrating type of dwelling house



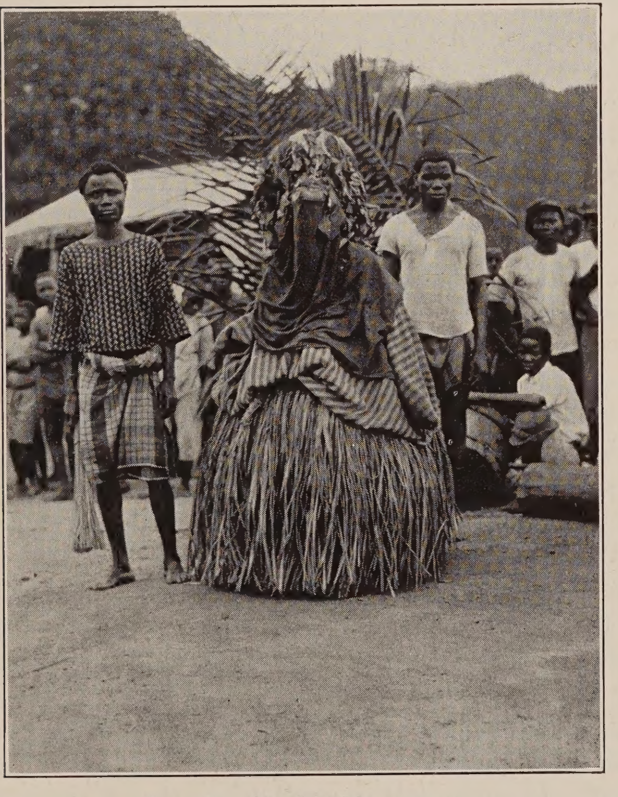
No. 64. — Inhabitants of town of Sordya

initiated, and upon his appearance in the village, women and children are supposed to go within doors and not to try to catch a glimpse of him. The devil or *polo namu,* as he is called among the Kpwesis, is a member of the tribe and usually an influential one. Theoretically he is supposed to be superhuman and never to die. Accident or death is said to be the penalty incurred by any uninitiated person or stranger who, whether accidentally or deliberately, lays eyes upon him. A great deal has been written about the devil of the bush school. However, much of it, so far at least as Liberia is concerned, can be considered as at least antiquated. For example, in spite of statements to the contrary, the great majority of adult natives, even in the interior of Liberia, do not stand in great fear or awe of the devil who presides over the boys' bush school, and do not regard him as a supernatural being. When the devil appears he wears a mask usually carved out of ebony or some other hard wood, to which is attached long imitation hair, and he is clothed in a voluminous dress usually made of palm filaments or leaves. Very likely the younger children are sometimes frightened at his appearance. The dress of the devil varies somewhat among the different tribes. The unusual or grotesque mask is, however, universal. Among the Bassas the mask is dome-shaped and made of wicker work with a round, painted, black and white face. Statements to the effect that if a devil appears in a village, any woman, child, or stranger seeing him is liable to come to harm or to fall seriously ill, are obviously not borne out by the facts.

There is a more or less definite course of initiation or education carried out in the bush schools, which are held at different times and in different places for the two sexes. The boys enter the bush school shortly before puberty, but they may enter at any age from seven to fifteen years. They are often urged to enter by their parents, and a boy may be brought to the door of the bush school by his father. Occasionally it is said that he is seized and brought in on the shoulders of one of the officials. Among some of the tribes the boys feign death just before being carried off to the school. In some instances they are given large amounts of palm wine to drink, or drugged before they are carried away. Goat's blood or flesh is then later spread about to impress the bystanders with the fact that they are really dead. Resurrection is supposed to occur when they leave the school at which time they receive a new name. The length of time which the boys remain in the bush school is said to vary among the different tribes from several weeks to several years. Among the Kpwesis and Golas, it is said to be several years, but it seems very doubtful that they remain in them continuously any such time. Actually the time spent must generally be much shorter, for many attend only for a few months and others only for a few weeks before the final ceremonies. Among the Manos the girls remain merely for a few weeks. Unless the boy belongs to a Mohammedanized tribe, and has already been circumcised, circumcision is the rite first performed. He is then tattooed or cicatrized with a tribal mark, according to the method of the tribe. The Krus and Grebos have abandoned circumcision and, indeed, have largely given up most of the ceremonies connected with the bush school. During the course of initiation at the school the boy is taught more or less of the mysteries of sex and his duties and responsi-



No. 65. — Devil bush

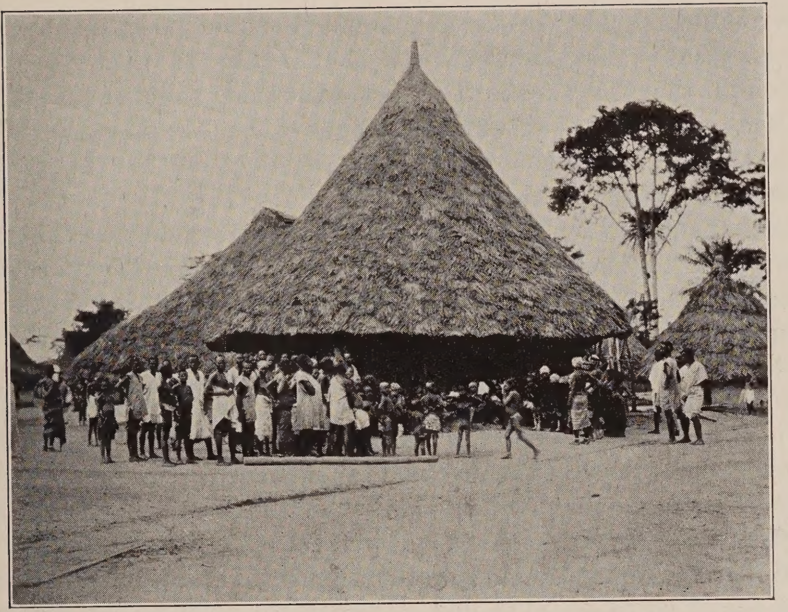


No. 66. — Devil in his costume

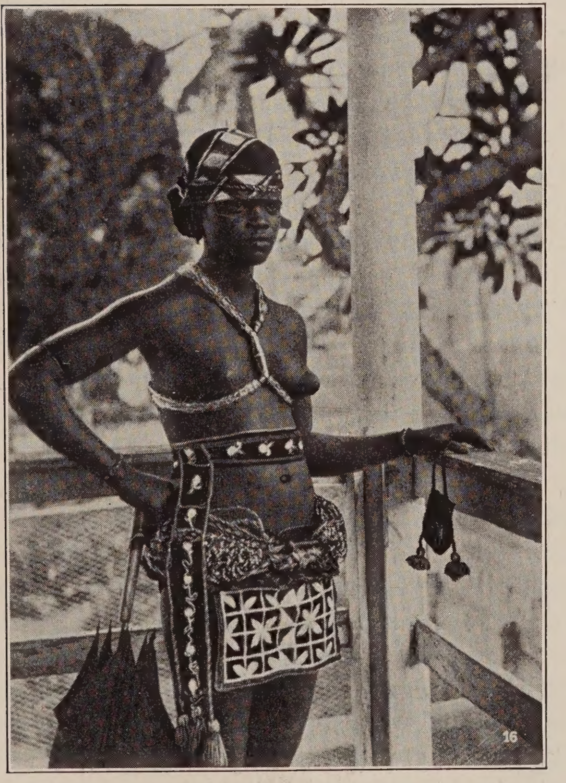
bilities as a future husband. The novitiates are also taught the sex lore traditional with their tribe, and the special marriage customs as well as the tribal dances and the method of drumming. It is said that a boy may be dismissed from the school if he is not sufficiently proficient in dancing. The tribal traditions relating to the art of warfare, and the preparation of land for farms are also a part of the education.

While at the bush schools the boys generally wear a dress made of raffia palm cloth or grass, which, however, does not cover the upper part of the body. Among some of the tribes, indeed, they go completely naked. Before ending the initiation they are said to undergo certain physical tests intended to establish their manhood. By some it is asserted that there is a sort of Masonic Fraternity among the members of the society who have been initiated in the bush school. Unless a boy has been properly initiated he is held in derision by his companions, and in some cases is not considered as a full member of the tribe or as a man of importance among them.

The sande, bundu, sembe societies, or grigri bush school for girls, is as important in the life of the natives of the interior as the school for boys. Some tribes maintain that it was founded by a woman who came from a country far away to the east where only women live, a legendary land and people of amazing exploits. Although the girls' school is a separate organization, it is said to be more or less under the control of the officials of the devil bush. It is nevertheless presided over directly by a woman devil called *femba* by the Vais, or *zogbe* by the Kpwesi. She is assisted by a number of attendants, and when she appears in public is, like the bush devil, masked, and wears a somewhat similar costume. Among the Bundu the mask is made from the shell of a coconut with the fiber left on except where a miniature face is carved and painted. Among some tribes all parts of the body of the femba are covered in order that it may not be exposed to the dangerous influences that emanate from people who do not belong to the society. The femba often carries a palm fiber fan in her hand which she waves as a signal, and thus communicates with her attendants without speaking. When she appears in public she, like the *poro*, is surrounded by attendants, who sometimes carry mats to help hide her. In other instances she will glide from among them and creep into the village street as noiselessly as a fleeting shadow, pointing with her fan or small bunch of twigs, her official wand of office, to what she wishes, and silently indicating by touch the girls who are to follow her to the bush school. She is supposed to have magical powers, one of the chief of which is that of conferring fertility on the women. Consequently she is held to be important in continuing the life of the tribe. Perhaps for this reason a great part of the instruction which the girls receive in the bush school particularly relates to sexual questions and to the preparation of the girl for marriage and motherhood. Childless women are said sometimes to consult the *femba* or *zogbe* asking for a charm to ensure conception. When a woman bears a child she is preferably attended by the head of the grigri bush. If this is not possible, it is extremely desired that she be attended by a woman who has been trained in the bush school. It is the rule in some tribes that if she is cared for by the



No. 67. — Dance in connection with entrance to grigri bush



No. 68. — Vai girl in wedding costume

femba she must confess her misdeeds to her. At birth the child is given a name which serves until it enters the bush school. In order to bring good luck to the newborn child, the *femba* takes it in her arms and, walking around the hut, lifts the body successively to the four points of the compass. A father is not allowed to be present at the birth and usually does not see the mother for at least several days after her delivery.

The time spent in the girls' school as in the boys' school varies considerably. Very frequently it is only a few months. The girl generally enters shortly before attaining puberty, that is, when she is from ten to twelve years of age, or occasionally even younger.

Both the entrance to and exit of the girls from these bush schools is as in the case of the boys a time of important celebration, and the ceremony is accompanied with much drinking of palm wine and with much fervent dancing by the women, which lasts most of the day and far into the night.

The chief woman dancer will suddenly run out from a group of companions and stand conspicuously motionless and waiting. At the first throb of the drum she will lift her arms and stretch upwards, then bend and reach down to her toes. Her waist begins to oscillate, at first slowly in a gentle tremor, then in ripples. These spread to her bosom, back and buttocks. They change to quiverings, to shudderings, and to violent convulsive movements. Faster and faster rumble the drums and more rapid and violent become the woman's movements. Every muscle from head to foot works until the agony of exertion seems to render her frantic. Then she will twirl round and round, faster and faster, until suddenly she drops, sweating and apparently senseless. After a second of absolute silence, there is tumultuous applause. Other groups of women then rush into the quadrangle dancing with earnest faces, yet with great abandon and almost with fury, their bodies vibrant, and breasts swaying, and feet stamping to the rhythm of the turbulent drums (No. 67). Then after a weird long call, and sometimes after explosions of some sort in the forest, the girls or boys are led away into the bush.

It is said that on entering the bush schools the girls are first rubbed with white clay and given a new name. Clitoridotomy is then performed, and sometimes other surgical procedures are attempted, and later the marks of the tribe are cicatrized or tattooed into their skin. In the bundu society among the Vais and Mendis, rupture of the vagina is also performed, since many of the women of these tribes say that if it is not performed, childbearing is impossible. The pubic hair is also plucked out. The girls then receive instruction not only in sex lore and all matters pertaining to sex relationship, but also in their matrimonial duties, and in the special tribal customs and duties pertaining thereto. They are also taught to dance and sing. The songs, however, are said to deal largely with sex questions. In the sande school some attempt is made to teach the girls about the useful herbs and plants in the forest. A girl will be given a leaf and sent out to find the tree. They are also taught how to prepare snuff, to select the tree, remove the bark and prepare it by boiling, fanning, and drying.

Instruction is also given in the meaning of taboos or fetishes, and why usually for superstitious reasons certain trails, villages or people should be avoided; why there should be certain seasons for collecting fruit from forest trees and herbs, certain seasons for planting, why certain land should not be used for farms. It seems unfortunate that they are taught nothing valuable about the care of children at birth. Umbilical hernia, for example, is one of the most common pathological conditions observed in Liberia. Nevertheless, it is said that it would be very difficult for a girl in Liberia to obtain a husband who had not first gone through her initiation at the bush school, and in the Vai language a girl who has not been initiated is called a "gboroa," that is, an ignoramus or idiot.

Toward the end of the term the girls are sometimes put through what is called a fattening period so as to make them more attractive to their future husbands. At the end of the term a great reception and procession is held when the families of the girls and their future husbands go to meet them. Following a great procession there is again dancing and feasting.

To take a girl out of the bush school at some time before the special and general ceremonies means to marry her. The bridegroom then makes a present to the *femba* and numerous other presents to the girl herself and to her parents. The "femba" then washes the girl's body and rubs it with fat and chalk, dresses her in a special costume, and leads her to the house that the bridegroom is supposed to have built for her. If any dissatisfaction arises with the girl on the first night, she can be returned to her parents, and the bride price, already paid, reclaimed.

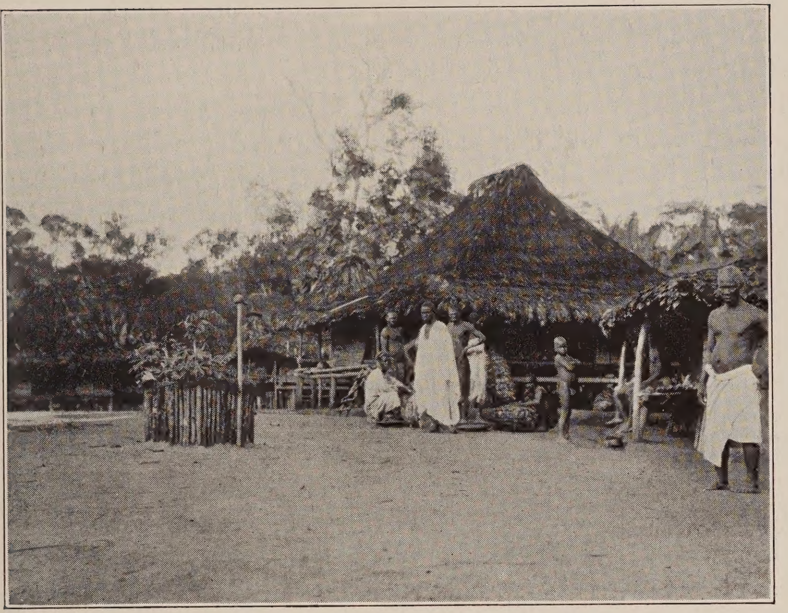
On leaving the bush, the girls always go through some form of ceremony; sometimes their faces and bodies are rubbed with chalk, and they are usually dressed in a special costume of grass, or in the case of some tribes, of cloth embroidered with beads and adorned with silver ornaments. Presents are also given to them by their prospective husbands and families. After several weeks' feasting, the girls are officially married.

In some parts of the country, the payments for the girls in the bundu school include a hamper of clean rice, a fowl, a jar of palm oil, a handkerchief and a bottle of local rum made from cane. For the betrothed girls who are initiated, there are extra bush charges of rice, fowls, dried fish and one *kasankra* (cane) of salt. In some instances the girls are kept at the expense of their future husbands. In the *poro* or boys' school, eight leaves of tobacco are paid at the outer gate of the sacred enclosure before entrance. Other payments of tobacco are demanded before the instruction is completed, as well as gifts of rice, chickens, and goats for the various officials, and sometimes money, particularly in the form of twisted iron bands.

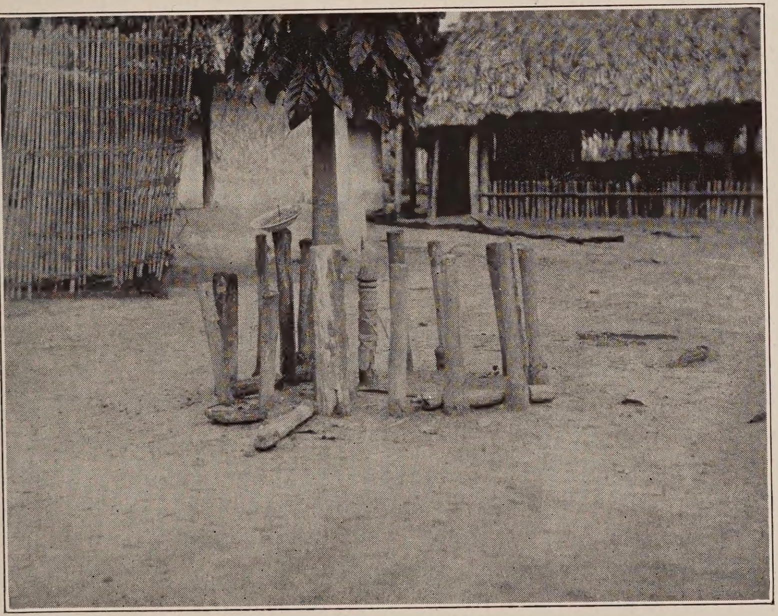
In some of the more modern of the schools, — the *Sembe* of the Temne, Mendi, and Vai tribes, — the girls are taught cooking, washing, the respect owed to husbands, the laws affecting women, farming, the preparation of palm wine, fishing, spinning, and other domestic duties.

Beliefs. Among the tribes in the interior death is considered unnatural, particularly if sudden, and is always supposed to be due to the machinations of some spirit. There is also more or less belief in existence after death. The spirit is considered either to enter some animal, or in other instances to become in some way concerned with the water or vegetation or earth. Sometimes it is believed that the dead man still knows what is going on, even though not able to talk or to move. His spirit, however, may become even more powerful after death than it was in life, and may become offended and pursue one. It hence must be provided with food, particularly for a short time after death. Consequently food is often placed on or near the grave where supposedly the spirit can reach it. The spirit must also be placated from time to time by various offerings or sacrifices and guarded against by wearing various charms. Special precautions must be taken not to offend it. If a person supposed to be of evil nature dies, arrangements must be made to prevent the return of his spirit. The body is sometimes buried at some distance from the village, and a circuitous route to the spot taken in order that the spirit may not find its way back. To the same end a fence a few inches high is built between the grave and the town. In rare instances the body is burned, which is supposed to kill the spirit. In other cases the spirit is appeased by sacrifices placed near the grave. Sometimes a vine or a rope is placed round the house with the idea of keeping off evil spirits. Westermann points out that among the Kpwesis the souls of the departed are supposed to dwell in communities in certain places, as, for example, either in or near a large silk cotton tree, or in the birds which hover about it. Sacrifices and food are consequently often placed in the haunted spot. As has already been intimated, the belief in fetishes and idols and their use is also more or less general among the tribes. The fetish is either worn or, more commonly, put in a public place in the town, or near the trail in the vicinity of a village. It is surprising to find occasionally fantastic offerings along the forest trail, such, for example, as a large leaf on which are placed a few rice stalks neatly tied together and a few kola nuts. The idea seems to be that the fetish is the abiding place of some spirit which may either ward off evil from one's self or bring bad luck to one's enemies. Among the Kpwesi tribe the word *sala* is said to refer to these fetishes, and the *sala* which is able to ward off evil may not be an inanimate object, such as a vessel of food in the center of the village under a tree or a small hut, but an animal, perhaps a chicken or a goat. Such an animal enjoys special liberty and care in the village. In other instances it may be a young girl or a woman who has the power to give luck to the community, and, if so, she lives in the house of the chief.

In the Bundu society or school, it is taught that a parrot overlooking a sleeping child or a playing babe means good fortune but the same parrot appearing near a woman who has laid aside a garment is the worst of omens. The head woman of the Bundu also warns expectant mothers not to walk over the shadow of a bird in flight, — especially that of a vulture, — or to step over a lizard running across the path. If, however, these errors are committed, the juices of certain plants rubbed on the forehead or over the nipples will avert the evil consequences. At a birth the noise of animals is harmful and so also is the presence in the house or in the garments of the attendants of any knotted string or material, but, on the other hand, the flight of birds about the house is among



No. 69. — Fetish pole, Towya Town



No. 70. — Fetish in the center of Lenga Town

the Bundu a cause for rejoicing. One of the strongest of all things to avert the evil eye is simply a hair plucked from one's own eyebrow and carefully preserved, or the nail of a dead man, the beak of a bird or a leopard's claw. The *bansare* leaf is said to be a sure defence against assault. The hair of an albino put inside the hollow of a blue bead is said to make lovers more loving, while the "cabe" or "oten," which can be had from many of the medicine men, is a thoroughly bad fetish that can be used for slaying of people by sympathetic magic. Butt-Thompson,[1] who has studied West African secret societies, especially in Sierra Leone, says that charms are used for every conceivable subject, to protect one's self or to harm another, to prolong life, to conserve strength, to ensure success in work or in play and in sport and in love, to gain the advantage in bargaining, to ensure the safety of crops and their full harvesting, and for purposes connected with marriage, childbirth, fertility, and death.

Fetish Doctors. With the belief in spirits is also associated the idea that certain persons possess supernatural powers, through which they can cause death or illness or misfortune to others. The medicine men or women are supposed to have such power, — a belief which becomes impressed on the other natives, in part by the knowledge which the doctors have acquired of local remedies prepared from roots, herbs, seeds or leaves. These medicine men or women are also supposed to have special knowledge of the efficacy of charms and magic. Indeed, it is said that of all the native authorities the fetish doctor comes first, since practically all of the business of life must be brought to him and pass through his hands. When a charm which a person possesses no longer brings him good luck, its efficacy is thought to be impaired by the action of an evil charm, and aid from the medicine man is sought in order that such action may be nullified. The valuable qualities of a charm are acquired either through contact and association with it, or through its incorporation into one's person. The possession of the skin and head of a leopard in one's hut or even its claws or teeth when worn, gives power and strength to the person to whom they belong. This power is not transferable and cannot be obtained by stealing the articles. Eating the flesh of the *Neotragus* or *Dorcatherium* antelopes is said to give fleetness of foot and skill in hunting, and drinking human blood and eating human flesh, to give greater strength and courage. The value of weapons used in hunting may also be increased by the use of charms. The manufacture of charms is the particular business of the medicine men, or witch doctors. Various parts of human or animal bodies, particularly the viscera, but also the flesh, skin, hair and even the sputum and saliva, are often dried and ground into a powder and put into a little bag, which is either worn or in some instances kept in some safe place in the hut, perhaps in a bottle. Not only have leopard's claws and teeth special powers, but also a number of vegetable powders.

The charms worn by the Mandingoes and Vais are usually quite different from those which we have been considering, and more commonly consist of verses of the Koran, worn as amulets. Their ideas of sacrifice are also bound up with their religion and are more particularly based on the killing of some animal.

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[1] Butt-Thompson: West African Secret Societies (1929), p. 64.

Divination from figures drawn in the sand by sifting, sprinkling or cutting is considered of very great importance, and can only properly be performed by a Moslem. Advice on almost every important subject is sought by this means. The sand sifter decides what form the sacrifice should take, why the hunter has not had good luck, whether injuries have been caused by man or by animal, whether a man has been murdered by a human being, or killed by a leopard. He also predicts success or failure in various ventures, and provides medicine for different ailments. His most mysterious power lies in his supposed mastery of the art of poisoning. In an entirely unexplained way, it is claimed that he can poison your water or food, or an object so that if you touch it you will die. He can even provide a poison that will act at a distance. If, for example, a person places some of it under the finger nail and waves the hand, it will be carried to an absent enemy.

Among the interior tribes, the ideas regarding charms, medicines and poisons seem to be closely related. Illness is regarded as being caused by an evil spirit, and hence the medicine man is called in to drive it away or placate it. Evil charms often are associated with the sputum, which should be quickly covered by sand or earth. Hair, and cuttings from the nails, are also of bad omen and should be burned. At certain times the excrement is considered to be poisonous, and should be placed in running water to be carried away.

Medicines and Poisons. Among the remedies that they may employ, little has been found of any distinct value. The snail shell is supposed to have special powers for healing wounds. Sometimes the whole snail is put into the wound; at other times the shell is powdered and the powder placed on it. Powders of the bark of the silk cotton tree, *Ceiba*, made from the thoroughly charred wood, and the skin of plantains also charred, are sometimes given internally. In some instances the method of treatment of the ailment can only be determined by the medicine man by the killing of some animal such as a fowl, and examining the movements of the intestines. Snake bite is sometimes treated by sucking the wound with the mouth. Severe bruises or contusions are also sometimes treated by sucking, and the poison is said to be withdrawn in this way. The medicine man may afterwards take from his mouth a piece of stone or wood or leather, and explain that it is the cause of the trouble. An aching limb or abdomen is sometimes lightly rubbed with the hands, and sometimes lightly scarified with a knife.

They still talk of pain as something caged and confined that can be set at liberty by cupping and blood letting. They tie a string round the temples to cure a headache. They try to relieve pain in the abdomen by painting the body with colored clay and to cure giddiness by "*mpuluka*" bark specially treated with oil and salt. Lung symptoms are sometimes treated with cassava water containing the essence of *madiadia* grass and the leaf of the *kuva* and *kiakasa* plant. For colic they give copious draughts of a fluid made from cassava root and the fruit of the *lembenzau.* They make suppositories from the juice of *sudia* leaves, salted and peppered. Poultices of cassava meal and acacia gum spread on certain leaves are also employed to heal wounds. For eye trouble some of the tribes use onion juice and salt, or powdered shell and molasses, lotus leaves and goat's milk, palm leaves and salt, or powder of sycamore leaves or sulphate of zinc and honey. The dry sycamore powder is also mixed with anything sweet, and used for diarrhoea. The sap of the *luwikiwiki* leaf mixed with oil is used for earache. They try to stop excessive bleeding with the boiled *luziezie* plant, which they also use as an anaesthetic. From the gum of the Euphorbia they make a salve for wounds and abrasions, and for an emetic they use the sap of *ndamba*. They also use many other gums in the cure of skin diseases. For the trial by ordeal they prepare draughts from the calabar bean and *mbundu* root, the *tangena* nut, the strophanthus creeper, the bark *muavi* of the *erythrophloeum* and from the white *datura* flowers. They also extract the venom from dangerous snakes and make their poisonous medicines palatable by mixing them with the juices of different fruits.

Among the magic potions, the Bori doctor has a medicine that he makes from powdered owls. Another is made of dried monkey flesh. For intestinal troubles, some use the chopped hair of the patients. For the same ailment the Butwa doctor splits a lizard down the back and places it over the spleen of the patient above perforations made in his skin. He paints sloughing ulcers with a feather dipped in water mixed with the scrapings of blue stone. Among other tribes, the soil of an ant hill is given for internal troubles. The Bundu women apply masticated food to the joints for rheumatism and arthritis, while the Nda doctor squirts pepper from his mouth into the eyes of a victim of epilepsy, and he also uses pepper as a cathartic in treating the same disease. From a crude dummy teat dipped in banana wine, the Nkimba men or women suck camwood and chalk for Saint Vitus' Dance, or, for gastric troubles, drink through it water in which stones have been boiled. Their doctors chew a pepper corn and spit the juice into the ears and mouth for brain diseases and make up smelling salts for headache and neuralgia by tying into a bundle, the fin of a fish, the head of a snake, the foot of a fowl, and the tail of a rat, all considerably decomposed.[1]

Among the many other vegetable preparations employed by the natives and medicine men of Liberia in the treatment of disease are the following: — Decoctions are prepared from the greenish bark of the tree (No. 421) *Anthocleista nobilis* to cure gastritis and from a mixture of the roots of the plant *Combretum grandiflorum* and the orchid *Liparis rufina,* for use in diarrhoea. The plant *Jatropha Curcas* is used both as a purgative and as an emetic. Some of the tribes also use it to cover rice during cooking, probably for its laxative effects.

Cassia, particularly the species identified by Linder, *C. kirkii* and *C. occidentalis,* furnishes leaves which contain senna in which chrysophanic and cathartic acids are present. Cassia is also employed as a purgative. It is found growing in the vicinity of a great many of the towns.

The epiphytic *Dinophora spenneroides* is said to be employed in the treatment of gonorrhoea. Another epiphytic member of the Piperaceae with fleshy leaves which are cooked with rice and administered to the patient, is used by the Vai for the treatment of fits. It is not known whether these two plants contain any definite active principle. *Hibiscus surratensis,* the leaves of which are covered with stiff bristles, is sometimes used by the native to scratch with, in the treatment of craw-craw, while the fruit of *Hibiscus esculentus* is employed as a mild aphrodisiac.

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[1] Butt-Thompson: *Loc. cit.*

The *Cola acuminata* (kola nut), of which there are several varieties in Liberia, is sometimes taken as a stimulant to the cardiac and nervous system. It causes a slight rise in blood pressure and is thought by the natives to increase muscular power. The glucoside kolanin has been isolated from the kola nut.

Some of the tribes also use the leaves of a verbenaceous plant, *Stachytarpheta indica,* which has blue verbena-like flowers and a long flower stalk, to make a decoction used in the treatment of fever.

Nearer the coast trade gin is used as an ingredient in, and solvent for, a number of native medicines. Among the more common of these medicines are the leaves of *Funtumia* and of *Colocasia* and the leaves and juice of the citrus plants; the bark of the silk cotton tree, *Ceiba,* and the skin of the green banana, both burned to ashes. Extractions of kola nuts and of several species of acacia are made, and various preparations in which ginger and palm oil and wine are employed are also used as medicines. Kaolin and iron rust are sometimes employed both internally and externally.

The Liberian natives are of course familiar with a number of vegetable poisons. One of the most important is Strophanthus, one of the Apocynaceae, of which at least two species have been found in Liberia, — *S. sarmentosus*, and *S. gratus.* They grow in bushes which produce the striking pink pentacle-like flowers illustrated in No. 405. This poison has been used especially for poisoning arrows. It is obtained by cooking the seeds in water and letting them evaporate to a syrupy, tarry mass. A small amount of vegetable resin is sometimes added. The action of the poison is known to the medicine men and it is said to be used chiefly by them. Strophanthin is the active principle, but the species *S. hispidus* contains another substance known as pseudostrophanthin, which is more toxic to the heart muscle. After poisoning, the victim's breathing and pulse become gradually slower until the heart beats suddenly cease. Frequently a convulsion occurs before death, the heart being arrested in systole. In smaller doses the drug acts as a circulatory stimulant.

Another member of the Apocynaceae employed as a poison is *Acanthocera* sp. It is prepared by mixing a decoction of the wood and evaporating it over the fire until it attains a syrupy consistency. The gall bladder of an animal is often added to the mixture if it is to be painted over the heads of arrows.

The poison known as Ouabain contains both an amorphous and a crystalline glucoside and produces very rapid death, which occurs after rapid irregular heart beats, rapid respirations and convulsions. Sometimes there is great loss of muscular power.

Hyoscyamus falezlez, one of the Solanaceae is another poison employed by some of the natives in the interior. It produces symptoms like those produced by Ouabain, but it is not so powerful a poison.

The bark of a tree of the Papilionaceous order *Erythrophloeum guineense* owes its poisonous action to the presence of an alkaloid erythrophlein. It is also a poison well known to the natives and is employed especially in the trial by ordeal, which will be described later. It is an irritant poison producing vomiting, purging, and collapse.

Capsicum has also been employed for producing burning in the stomach, vomiting, colic, and diarrhoea.

Gloriosa superba (No. 143) of the Liliaceae also produces a well known poison, of which the active principle is superbine, which has an action somewhat similar to that of scillin. The plant, however, sometimes has an action resembling that of aconite, the symptoms of which may appear in a half hour, and may consist of a tingling of the lips and throat, retching, violent vomiting, with spasms and contortions of the body, racking pain, cardiac depression, and collapse. Death may take place within a few hours. Autopsy discloses congestion of the brain and meninges, and sometimes extravasations of blood, congestion of the viscera, and an inflammatory condition of the mucous membranes of the stomach. In the Far East *Gloriosa superba* is often employed as an abortifacient.

Hall and Whitehead [1] have recently studied the poison on a few arrows of the East African Heikum tribes. They found no evidence of alkaloidal poison on the arrows. The crystalline product obtained was, however, toxic for frogs, guinea pigs, and cats, and caused death by stopping the heart in marked ventricular systole. It could not be identified with any known poison but in some respects resembled the glucoside Ouabain. Anaerobic bacilli, such as *B. histolyticus* and *B. Welchi*, and several other micro-organisms were also found on the arrows. Neither *B. tetanus* nor *B. botulinus* were found. The investigators call attention to the fact that most wounds are likely to be infected with bacteria.

Peirrier [2] has recently studied a number of poisons used by the natives in the Cameroons. Among them is one called *N'Sou,* which consisted of leopard's feelers cut small and impregnated with an extract made from a mixture of vegetable poisons. It is said that the hairs are spread on the victim's chair or bed, that the poison enters through unnoticed lesions which may be present on the skin, and that death follows in from six to twelve hours. According to the author's analysis a number of different ingredients were present in the extract. Two were of animal origin. One was from a venomous toad, the whole of which had been dried and pulverized. The venom of the toad contains two alkaloids, one of which acts like digitalin, and the other paralyzes the muscles. A black scorpion of the genus *Buthus* was also employed in preparing the poison.

Of the vegetable poisons present one was *Erythrophloeum guineense.* Peirrier says that when this poison is used in the trial by ordeal *Strychnos* bark is often added. Another poison is known as *Bottoto.* It is made from the bark of a tree, and will kill a dog with tetanic convulsions. He suggests that the active principle of this poison is curare, furnished by *Strychnos Icaja.* From this bark, he says, the fetish men prepare a concoction which is employed in trial by ordeal. The patient is told to jump over a stick half a meter from the ground. If paralysis prevents him, he is judged guilty.

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[1] Hall and Whitehead: Jour. Infect. Dis. (1927), XLI, 51.

[2] Peirrier: Ann. de Méd. et de Pharm. Colon. (1928), XXVI, 299.

Butt-Thompson makes the remarkable statement that certain of the West African native society doctors "in one thing at least have anticipated a late discovery of modern pathology, for they have long cured general paralysis by allowing the patient to be bitten by malarial mosquitoes. This is done because they believe it is beneficial to put rival germs (although they do not give them that title) into deadly conflict. The doctors of Mungi, Ukamba and Ndembo fight the vidudu or paralysis with the pilinter of malaria, these terms being their equivalent for bacilli."

He gives no authority for the statement. We are inclined to question it. We heard nothing of such an idea in Liberia. In fact, generally speaking, paralysis was not observed in Liberia, and in parts of central Africa also, general paralysis is often very rare.

Customs Regarding Death and Burial. Among most of the tribes, with the exception of those in the eastern and northeastern portion of the country, it is customary after death to expose the corpse for a day or two before burial. In some instances the time is extended to several days, in which case cannibalism is less likely to occur, for it is well known that freshly-buried bodies have often been exhumed and eaten. The members of some tribes believe that supernatural powers are obtained by eating such flesh. If the dead body is that of a chief or other important person in the village, it is often rubbed with kaolin and laid on a bier. While it is thus exposed the women of the family and of the village weep and wail over it, and in some communities a fire is kept burning and drums beating to ward off the evil spirits. Westermann says that among the Kpwesi when the king dies his viscera are removed and that the body is then filled with dry herbs and smoked to preserve it. We were unable to verify this statement. In many instances before burial the body is sewn into a mat. Among some of the tribes it is customary to bury pieces of cloth with the corpse. All the articles of clothing or cloth so buried are torn or injured a little in order to "kill" them. If the deceased is a woman, her beads or a bracelet may in addition be buried with her. A vessel containing cooked food is frequently put in the hand, and the Krus often put an empty bowl on the top of the grave and from time to time place in it a little palm oil or a small quantity of cooked rice. If the dead man was a chief, a hut may be built over the grave and even a chair or hammock placed in it for the dead to rest upon. The graves are usually shallow, no more than from two to four feet in depth. With some tribes it is customary to pile the earth or rake it up with the elbows on the top of the grave until it is several feet high, and then to beat it flat and to place flat stones upon the surface. The grave is also often enclosed with stones.

The cemeteries are rarely within the villages, more often they are situated just outside the entrance or the exit. The graves are arranged in small clusters, sometimes beneath a large tree. The Vais often mark the site of the graves with a stick to which is tied a small piece of cloth. Along the coast the small islets have been frequently used for burying grounds.

Birth Customs. Pregnant women work as usual until the pangs of labor begin. In some tribes it is customary for the woman to go to the bush to be delivered, but with most tribes the delivery takes place in the woman's own hut. Westermann says that among the Kpwesis, a woman before giving birth to a child, is sometimes laid for hours or days in stocks made of plantain stalks to prevent evil spirits from entering her body and interfering with the birth of the child. We did not observe this custom. If the woman is of any importance, one of the "femba" usually attends her. The Mandingo women remain in the house and do not go out until seven days after the birth; the new-born child's head is shaven and a cap placed on it. In the other tribes the child is rubbed with palm oil. The husband is never present at the birth, and has no further connection with his wife until the child is weaned, that is, for about eighteen months, or even longer. This fact is used as an argument for polygamy. Although the children are weaned late, they nevertheless are fed on milk alone for only about three months. Small pieces of mandioca root or of dried green bananas are then added to the diet. Later rice is also given. Apparently neither goat's milk nor cow's milk are given to children, nor is milk used generally by the natives in the interior. The children of some of the interior tribes are weaned and taught to eat by tying them upon a board and pouring mandioca or rice soup on their face and mouth from a ladle held a foot or two above the child's head. The child naturally beginning to cry of course opens its mouth, and when it draws in its breath it must swallow some of the food; thus it learns to eat. The child is usually carried on the mother's back as illustrated in Nos. 39 and 57, and is simply tied in place with her one-piece skirt. It of course wears no clothing, not even a loin cloth, until puberty is reached.

The Leopard Men. The "leopard men" or "human leopards" are still found in Liberia among the Mas and Gios. The activities of this society or of similar groups of men have long existed, not only in Liberia, but also in parts of Sierra Leone and of the Ivory Coast, and much has been written of them. It is not known, however, that the human leopards of Liberia have any definite connection with similar groups in other countries, and it has been supposed that their customs differ somewhat. The members are generally men, but women have also been known to be connected with the societies. The ceremonies are said to be held in the forest, and the special marks of the society are scarified on the new members on that part of the back which is covered by the loin cloth. It is also said that an oath of allegiance to the society is taken, by which absolute silence regarding its activities is imposed, and that violation of this oath is punishable by death. The society is greatly feared by some of the tribes. Natives in certain districts are terrified at the mere idea of walking outside the village and along the forest trails at night. In certain neighborhoods all the important men of the tribe are believed to be members. Our information regarding these people in Liberia was obtained particularly in the eastern central regions of the country and from government officials at Tappi Town, where a number of leopard men were seen. The leopard is the emblem of the society and constitutes its totem. When on killing expeditions the members dress themselves more or less in leopard skins and either paint their bodies with annatto dye or rub yellow clay upon them. In some instances they carry a net which they throw about the body of the victim. They are armed with sharp iron hooks in the form of leopard's claws and teeth, and also carry short spears. They are said to imitate the movements of leopards by bending and crawling. Usually the victim is attacked suddenly along the trail at night, and if he escapes, he is sometimes at a loss to know whether he has been actually attacked by an animal or by a human leopard, for in some instances leopard fur is placed around the iron claws, bits of which may adhere to the clothing of the victim or to his wounds. We saw one person who had been terribly mauled supposedly by a leopard man. Sometimes a person is suddenly attacked when he is working in the forest. Women are said to have been carried off when they were washing clothes in a stream. As the men slay in bands, the victim is supposed almost never to escape. The bodies of the slain are cut up and the meat distributed often to other members of the tribe, including the women. On several occasions we found human bones near the trail.

Human flesh is the fetish of the society, and the consumption of it is believed to give special power. Although the desire for animal food in a region where animal flesh is scarce certainly plays a part in these slayings, the killings, it is said, are primarily made that the flesh may be eaten ceremonially in order to vitalize the charm of the society; that thus strength may be brought to the members and protection given to the community.

The charm of the society, which is said to be kept in a small bag, is carefully guarded, and consists of various articles such as coagulated blood or pieces of flesh and bone either of man or of animals. Some of the blood of the victim is poured over the charm at the ceremonial exercises.

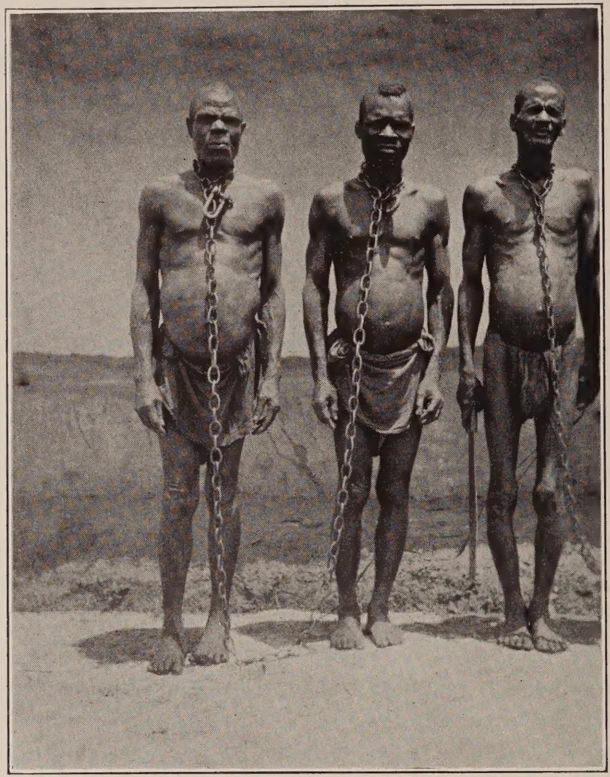
Among the Gios at times when it is difficult to obtain victims from outside their own villages, it is the custom to select as victim a person either in their own or in an adjacent village, preferably one of the older people. The members will sometimes argue regarding the person to be selected; one member pointing out to another that as he furnished his grandmother for the last ceremony, it is "now your turn to furnish someone from your family." The Gios will also dig up for the ceremony anybody that has been recently buried, and indeed among them this practice seems here to have become a matter of course. In some instances after a victim has been selected by the society, one of their number will go to the village at night and call the name of the doomed man while he sleeps. So powerful is the magic of the society and so great its power, it is maintained, that the victim himself will often feel compelled to get up and walk out of the village upon the trail, perhaps to his death. It is perhaps of some significance that we saw no cemeteries or groups of graves anywhere about the interior villages in eastern Liberia.

The Gios have generally adopted as their totem the chimpanzee, called by them *baboon*, which they protect and regard as sacred.

The Government of Liberia has already done a good deal to put down the activities of the leopard men. However, they were especially active in eastern Liberia at the time of our visit. Nevertheless the problem is not believed to be a difficult one to deal with, provided that it is handled intelligently and a really efficient frontier force is maintained in the district, and provided also that some attention is paid to the food problems of the natives.

In certain parts of the eastern Kru coast, the use of human flesh and fat for charms, fetishes and sacrifices has existed sporadically until very recent times, and the missionaries tell many stories and cite many instances of individual natives who have been killed for this purpose.

Trial by ordeal still persists among the people of Liberia. Practically all the tribes believe that it is a most efficacious, and even an infallible means of identifying a guilty person, and establishing his guilt. This implicit belief in the efficacy of the trial by ordeal naturally makes the superstitious people attach the greatest importance to it, since a greater or less degree of faith in witchcraft is almost universal among them. In Liberia the commonest form of it consists in compelling the suspected person to drink a concoction known as sasswood, which is prepared from the bark of a tree of the Papilionaceous order, *Erythrophloeum guineense*. This concoction, owing to the action of an alkaloid, erythrophlein, constitutes an irritant poison the strength of which varies greatly according to the amount of bark employed. It is usually prepared by the local medicine man, who consequently has it in his power so to vary its strength that it will act only as a violent emetic or as a very potent and violent irritant poison. His personal opinion, or conviction as to the innocence or guilt of the accused person undoubtedly



No. 71. — Convicted leopard men

often influences him in deciding what strength to give the poison, or he may be bribed. He also knows of course that fear will help to betray the criminal. It is almost impossible for a native suspected of any serious crime to avoid the trial by ordeal unless he is able to escape from the community in some miraculous way, — a thing not easy to accomplish in such a country. Even in Monrovia, the trial by ordeal is not infrequently employed or recommended by the Americo-Liberians in order to detect guilt in case of theft or other crime.

Among the Boriowah, whose customs influence a number of the Kru tribes in the interior, particularly the Gibis and Grebos, the medicine doctor uses a trained lizard to aid him in the preliminary work of detecting the criminal. This lizard when held in the palm of the hand of the doctor, is supposed to point to the guilty person; suddenly it will leap to the garments of the shivering, frightened man and cling to him until it is removed. If the person is actually guilty he will sometimes believe that he has been detected, and confess his crime without undergoing the ordeal.

The manner of conducting the trial and the interpretation of its results vary somewhat among the different tribes. However, it is generally accepted that if the person undergoing the ordeal dies from the effects of the poison, he is certainly guilty of the offence, and that his guilt has unquestionably been proved. When, however, the evidence of the guilt of the accused seems conclusive to those concerned, and he nevertheless does not die on drinking the first potion, a second is given him, or even a third or more. When the native is really guilty, his belief in the efficacy of the test is so great that he will often confess his crime, — especially if the irritant poison causes vomiting, retching and abdominal pains, and he becomes frightened and feels that judgment has descended upon him. Among some of the tribes, if the patient immediately vomits, the medicine man and the authorities concerned judge him not guilty, and if the crime is not a serious one, the matter ends. But if these authorities have already investigated and convinced themselves that the victim is not to escape, or is really guilty of a serious offence, then cup after cup of the sasswood mixture is forced upon him until through fright or despair, he either confesses or falls into a stupor and dies. We have been informed that in some instances from twenty to thirty cups of the mixture have been forced one after the other upon the victim. Among the Krus, in the trial for theft, the accused is considered guilty if the mixture acts as a purge, and either he or his relatives or friends are expected to return the amount of the theft, and to pay the medicine man who has prepared the sasswood and conducted the trial.

Government officials have employed the trial by ordeal with sasswood successfully in a number of instances, particularly in the interior of the country, in detecting members of the human leopard society, suspected of murder and cannibalism. Three of a number of leopard men we saw are illustrated in No. 71. After undergoing trial by ordeal and being compelled to drink cup after cup of sasswood and after repeated attacks of vomiting, retching, and pain, they finally confessed to their crimes. On recovery from the effects of the poison, they were placed in chains and sentenced to hard labor for life. It is said that a person who is judged guilty as a result of trial by ordeal, which is called among the Kpwesis, *zalo*, and among the Grebos *gedu*, will as a rule not insist on his innocence even when actually guiltless, for he often believes that some other misdeed has brought the judgment upon him. Denial, it is said, would be useless in any case, for public opinion would uphold the verdict of the trial.

The belief in the influence of the mind over the body in bringing about confession of guilt, has apparently existed from the beginning of our knowledge of the trial by ordeal. One of the earliest references to such a trial is to be found in the Bible in Numbers, V, 17, where a description is given of the method of administering to a woman charged with unfaithfulness, the bitter water mixed with the dust of the tabernacle floor, with a curse laid on it to cause her belly to swell and her thigh to rot, if guilty. Whether poison was placed in the "bitter" water is not clear.

In connection with the persistent and extensive practice in Liberia of this method of attempting to detect guilt, it may be of some interest to recall that the trial by ordeal lingered even in Europe as a custom having the force of law until at least three or four centuries ago. Trial by ordeal is also still employed in some parts of the tropical world outside of Africa, especially India, and in Brahmanic law, in such trial a decoction of the aconite root is one of the poisons given, the accused if not becoming seriously ill is declared innocent.

VI

LANGUAGES

Our knowledge of the languages of the tribes of Liberia we owe principally to Johnston and Westermann. These tongues fall into five groups: — Mandingo, Kpwesi, Kru, Gora, and Bulom. The Vai, Mendi, and Kono languages resemble the Mandingo, but the languages of the majority of the tribes are more like the Kpwesi and Kru rather than the Mandingo. Like the languages of other West African groups, the Mandingo language resembles Bantu in grammatical structure except in the use of suffixes instead of prefixes. In Mandingo, as in all other forms of purely negro speech, there is no distinction of gender. Its phonology is harmonious and it is relatively easy for those speaking English to pronounce. It also resembles languages of the Bantu group in its frequent use of vowels and the desire as far as possible to place a vowel between each consonant, except where semi-vowels like the nasal *m*, *n*, and *r* are used. As in Bantu, no word can end with a consonant. Johnston points out that for the word "ten" half the Mandingo dialects have *tamu*, *tam*, *tan*, and that the other half have *fu*, *pu* or some variant of it. Sibley and Westermann [1] accept the classification of the Mandingo tongues on this basis and separate them into two main divisions: — the Mande-tan and Mande-fu. The Mande-tan are the languages of the people who are generally referred to as Mandingoes, and who occupy particularly the country beyond the forest belt, except for the Vais who have advanced to the coast. According to Sibley and Westermann two tribes speaking Mande-tan languages are represented in Liberia, — the Malinke in the northwest, and their neighbors the Vai who inhabit the west coast region especially between Cape Mount and Monrovia. The Kono, who live further north and who are separated from the Vai proper by a group of Mendes, speak a Vai dialect and are near relatives of that tribe.

The Vai language has a great similarity to Mandingo and like it is a harmonious tongue, relatively easy to pronounce. It has a grammar that is said by Johnston to be reasonable and far from difficult. The rather cumbersome system of writing used by the Vais has already been referred to.

The Kpwesi dialects show a decided affinity with the Mandingo group, and at the same time bear in some of their roots some slight resemblances to Bulom. Johnston says that these resemblances, if they are real, are undoubtedly due to derivation of the Kpwesi from a very ancient West African mother speech. Sibley and Westermann list the tribes speaking Mande-fu languages in Liberia as the Kpwesi, Loma, Weima, Gbandi, Gbundi, Mano, and Gio. These tribes all speak dialects of one common language which Sibley and Westermann believe could become the predominant one of the country of Liberia, and that books written in the main Kpwesi dialect could soon be understood by all members of the other tribes. They point out that the Mande-fu people, though speaking a Mandingo language, are in their outward appearance and in their civilization more closely allied to the Kru group than to the Mande-tan.

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[1] Sibley and Westermann: "Liberia, Old and New" (1928), p. 52.

The people speaking the Kru languages cover much of the southeastern half of Liberia, beginning on the west with the De dialect which is spoken on both sides of the lower St. Paul River. The De dialect links on with the Mamba, which is a dialect of the Bassa-Gibi language much spoken in south-central Liberia. Many different dialects of Kru are also spoken in the territory on the coast beginning with the Sangwin River and extending east to Garawé at which point Kru merges into Grebo. Johnston points out that although between the Sangwin River and the coast the speech of Sikon and Putu bears a considerable resemblance to the Kru language, it has a somewhat stronger affinity with Mandingo and Kpwesi.

Padebu is the dialect of the interior of eastern Liberia beyond the Grebos. The Grebo group of dialects is relatively large, for its range extends over the west part of the French Ivory Coast, especially in the littoral region. It should rightly include Padebu and all the other dialects in the southeastern part of the country which use as a tribal designation the suffix *bo*, *po*, etc.

All the Kru dialects are very nasal. They employ an aspirate before several consonants, rather clip the vowel sounds and show a preference for joining of a trilled *r* with a dental, guttural or labial, without any intervening vowel.

The roots of the Gola language which is comparatively restricted in range, show no distinct relationship to adjoining forms of African speech. It is no doubt an old descendant of the original mother tongue of West Africa, and according to Johnston bears very slight resemblance in its vocabulary to the Kru and Mandingo groups. There is in it an occasional suggestion of some remote affinity with Fula and even with Bulom.

The Bulom language is represented in Liberia only by Kissi, which is spoken to the west of Boporo near the Sierra Leone border. Kissi is clearly related to the Bulom group of southeastern Sierra Leone in its word roots, but has developed a very different grammatical structure, for its nouns change from singular to plural by an alteration in the termination and not, like Bulom, by the application of a prefix. However, the Kissi language has not been thoroughly studied. Sibley and Westermann included the Gola and Kissi people in the same linguistic group, and state that perhaps they are both allied to the Temne and Bulom tribes of Sierra Leone.

In the eventual development and civilization of Liberia, most of the dialects and languages will probably disappear. The Kru language is too difficult of pronunciation either for English-speaking people or for most of the other tribes of Liberia to master satisfactorily. Gola is spoken to a very limited extent. The Kpwesi language is spoken by the largest number of people, but it has a number of dialects and its use is not likely to become more general.[1] The writer believes the Mandingo or Vai language would probably supersede it to some extent should no further civilization of the country occur, and none of the other languages have been reduced to writing by the natives themselves. Indeed it has been suggested that Vai will probably become the dominant native speech, not only because it is similar to Mandingo and is much more harmonious and much easier to pronounce than the other dialects of the Liberian tribes, but also because the grammar is said to be reasonable and not difficult. However, since so many dialects are spoken in the interior of the country, it seems obvious that English will in time become the general language of the country. As Johnston points out, the negro can often acquire languages totally foreign to his own with far more facility than the ordinary European. Many of the inhabitants of Liberia already speak English and one or two of the dialects of the interior tribes. Our servants and interpreters sometimes spoke three native dialects in addition to English. English, of course, is the official language of the country, and, as Sibley [1] points out, it seems to be the desire of the native chiefs as well as of the government, that it should become the general language. It should really be made the one language of all the schools which are started not only on the coast but in the interior. The wisdom of such a course has been thoroughly demonstrated in the Philippine Islands where the people formerly spoke many dialects in different parts of the country.

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[1] Westermann (Preface to "The Kpelle Language in Liberia" by Westermann and Melzian, in co-operation with the Firestone Plantations Company and the American Advisory Committee on Education in Liberia, Berlin, 1930) considers that Kpwesi (Kpelle) is one of the important vernacular languages of Liberia, — perhaps the most important. He admits that it is not easy to learn.

[1] Sibley: *Loc. cit.*, p. 294.

VII

SLAVERY

SLAVERY in the usual historic sense of the term does not really exist to any appreciable extent in Liberia. The people referred to as slaves are rarely confined or seriously mistreated. I have already referred to the practice among Americo-Liberians of taking aboriginal children into their houses for housework, and of occasionally giving the chief of the tribe, or the person furnishing such children, a "dash" or present in compensation. The problem that this custom presents, is, however, except in the case of young girls or women, not a serious one. The pawning of women has already been discussed. Slavery is of course forbidden by the constitution of Liberia. Attention has also been called to the fact that in earlier years a number of the interior tribes were concerned in the slave trade. A number of persons also became slaves when captured as prisoners of war, and not redeemed by their tribe.

Westermann,[1] in discussing the social organization of the Kpwesi tribes states that the people are classified in three groups, — free persons, serfs, and slaves. A free person cannot be sold by the chief or by private persons unless he has committed a crime, and even then he may be redeemed by purchase. Every person born of free parents is classified as a free man. The woman who has been a serf or a slave becomes free when she marries a free man. If a free man is captured in war, he becomes a slave, but he returns to the community as a free man immediately the sum required to redeem him has been paid. Children of women who have become slaves through capture in war, are always considered free, whereas the children of purchased slave women are usually counted as slaves. Every slave, however, can obtain freedom by redemption. To the class of serfs belong, first the children of slaves who are born in the house of their master; second, their descendants in all following generations; third, people who upon their own initiative have become serfs or who, while children, have been presented to a chief or other wealthy person. Their descendants likewise remain in the position of serfs. Like a free man a serf cannot be sold, but unlike a slave, he has not the privilege of redeeming himself. However, it is the prevailing custom often to bestow freedom upon serfs. Generally, the slaves are persons captured in war who have not been redeemed within a specified time. A few have been enslaved on account of crime, and some have been brought from abroad more particularly by the Mandingoes. Their lot is not apparently a hard one, and it is said that they are permitted to acquire private property. Many of them apparently live under similar conditions and eat the same food as the majority of the inhabitants of a district. They seem, however, to have no responsibilities and no voice in the election of the chief or in the administration of the town.

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[1] Westermann: *Loc. cit.* (Die Kpelle).

Among some of the tribes it might be impracticable to discriminate between the status of wives and of female slaves acquired by purchase. Many of the slaves are naturally females and their position in the villages apparently does not differ greatly from that of a wife. The man in most of the tribes actually purchases his wife for a sum agreed upon in currency or in goods which he pays to her responsible relatives. In a way she then becomes the man's property. He usually gives her a piece of land to cultivate which he has cleared in the forest and a house which they may erect together on this land. All the produce of the farm belongs to the man and must be turned over to him. The wife, however, must do all the farm work such as the planting, cultivation, and gathering of the crops.

The most important problem of the hinterland, however, is not connected with these instances of more or less domestic slavery among the tribes, which could probably be easily dealt with through arbitration with the chiefs of the different tribes and all the actual slaves set free at a comparatively small cost. The really great problem lies in the various forms of oppression practiced on the interior people, particularly in respect to road and farm work, taxation, and to the actual abuses which are practiced upon them and which still seriously interfere with and retard their development.

In order better to control the conditions in the interior of the country, the Liberian Government in 1905 passed a law for the government of districts inhabited by aborigines. This Act provided that every district inhabited exclusively by an aboriginal tribe should be regarded as a township, the people of which should have the right to choose a chief, *subject to the approval of the President of Liberia,* and be given land upon an agreed basis. The native districts were to be supervised by district commissioners appointed by the President and endowed with judicial as well as administrative powers. Every chief and his council constituted a court for the preservation of order and the settlement of disputes, but appeal could be made from the verdicts to the Liberian district commissioner. The unfortunate relationship which exists between the Liberian Government and the indigenous tribes in the interior will now be discussed.

VIII

GOVERNMENTAL CONDITIONS IN THE INTERIOR

For administrative purposes the hinterland of Liberia has been divided by the government of Monrovia into five districts, placed in charge of an Americo-Liberian known as a Commissioner-General, responsible to the Minister of the Interior, and appointed by the President. Under the Commissioner-General, a Liberian District Commissioner administers each interior district. There are also several Assistant Commissioners and Station Agents under his direction. At present there are said to be seventeen Liberian District Commissioners. According to the Liberian regulations, "it shall be the duty of the District Commissioners to protect the Chiefs of the tribes and their people from any exploitation or infringement of their rights by traders, travellers, or any other strangers in the interior, and to assist and protect the Chiefs and their people in marketing their products and making their purchases, seeing that they get fair prices in both buying and selling." It is expected that the District Commissioner will respect the Chief and head men, and that they on their part will act as far as possible in harmony with the Commissioner. If, however, any Chief fails to respect the Commissioner, he is liable to punishment. "The District Commissioners shall encourage the people to commence farming and to see to it that no public or private work interferes with farm operations. No officer or soldier of the frontier force or court messenger shall menace or impede any native who may wish to make a complaint to the Secretary of the Interior, or take any woman to any barracks or station without first paying the proper dowry." This catalogue of prohibitions suggests that these practices were current. The frontier force stationed in the district is under the control of the District Commissioner, and cannot engage in expeditions except under his orders. Furthermore, according to the Liberian regulations, "the Paramount Chiefs who are elected by the natives concerned without any interference from the Government" and commissioned by the President, are responsible for maintaining peace, undertaking public work, and collecting taxes.

Each district has three courts, — the court of Chiefs, the court of Paramount Chiefs, and the court of the District Commissioner. The first court adjusts only minor disputes within the town, and appeals from it may be taken to the court of the Paramount Chief. The latter court tries cases of non-performance of government obligations or all "woman palaver" cases (as to who owns a woman or wife, etc.) and cases of witchcraft. It also has authority over cases between residents of different towns under the Paramount Chief, but not over serious criminal cases. Appeals may be taken from this court to the District Commissioner who has authority to impose fines not exceeding one hundred dollars and imprisonment not exceeding one year. It is said that few hinterland cases ever get to the attention of the Commissioner-General at Monrovia. The regulations further stipulate that native Chiefs can be required to furnish District Commissioners with no more than one hundred and twenty-five hampers of rice and two tins of palm oil a month, which articles apparently must be provided free. The regulations also lay down rules in respect to pawns and dowry, and they fix the damages to be paid for adultery at three pounds. ''If a man is enticed by a woman, however great a flirt she may be known to be,'' he must nevertheless pay her husband or parents the above sum. Other sexual offences are punished with fines ranging as high as twenty pounds.

The principal obligations imposed on the native population of the interior by the Liberian Government are the hut tax, labor for road work, labor upon the government farms, and labor for porterage. According to the Liberian regulations the Chief of the village makes an assessment of the huts and collects the tax under the direction of the District Commissioner, and in return receives a ten per cent commission. The annual hut tax is one dollar, but it is said that the tax is not limited to that amount if more can be obtained from the taxpayer, and that it may be collected more than once a year. The Commissioners of internal revenue, however, frequently complain that certainly part of this money does not reach Monrovia but is retained.[1] Nevertheless, the amount collected from the hut tax in the interior has steadily increased. In 1911 it was less than $10,000 but in 1925 it was estimated at $178,540. In other words, the government at Monrovia is obtaining a greatly increased amount of money from the natives in the interior, who yet cost the government nothing. According to the statement of a number of natives in the interior, the District Commissioners

No. 72. — Government road construction

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[1] Report of the Secretary of the Interior of Liberia (1919–1920), p. 16.

themselves make regular tours at different times of the year to the towns and villages of their districts. Regarding some of these visits we have personal information. On these tours the District Commissioner is accompanied by a large retinue consisting of women attendants and servants, and sometimes of a few soldiers preceded by drummers or men who toss knives into the air as the approach to the village is made. The District Commissioner is carried in a chair suspended from poles on the shoulders of porters, who work in relays of eight.

Official regulations require the natives of the hinterland to furnish porters for the government. The Commissioner General and the Major commanding the frontier force are each entitled to thirty-two couriers, a District Commissioner and a Paramount Chief may each have sixteen.[1] The porters receive no pay. Sixteen porters are all that the District Commissioner needs to carry his chair from one village to the next. After these visits the towns or villages are frequently left in at least temporary destitution, for apparently almost everything of value is taken away. Goats, poultry and other food supplies, the few animal skins or articles of native manufacture in the town, and sometimes even the young or more attractive girls disappear. There is no redress for the extortion; to avoid it villages are sometimes abandoned and groups of natives sometimes abscond across the border not always to return. This practice of raiding by the District Commissioners, however, has become more or less known. In 1926 the Liberian Legislature made an investigation in which two aboriginal native commissioners (not Americo-Liberian) were concerned. It disclosed the fact "that in the name of providing entertainment for the President who was making a tour of the hinterland" several native Commissioners had collected from the natives without payment about two hundred goats, five hundred and eighty-five hampers of rice, forty tins of palm oil, four hundred chickens and other articles of food, to the total value of $1600. Although the President found it impossible to visit the area, the Commissioners kept the food. After the investigation the House of Representatives passed a resolution asking that the salary of one of the aboriginal commissioners be withheld until he returned the articles *to the government*, and that the other commissioner be dismissed. Obviously, however, it is exceptional to make any excuse, such as a possible visit of the President, for such raids upon the villages.

Attention has been drawn to the fact that the District Commissioner is required to encourage the people to commence farming and to see to it that no public or private work interferes with farm work. According to the statements of natives in some districts in the interior, the farms in the vicinity of the government compound occupied by the District Commissioner, are government farms or farms appropriated by the government. In any case, the produce from them, notably rice, is requisitioned by the government or by the District Commissioner, and is threshed within the government enclosure of the district by women who work during the threshing season approximately from sunrise to sunset, under the direction of soldiers, members of the Liberian frontier force. The women

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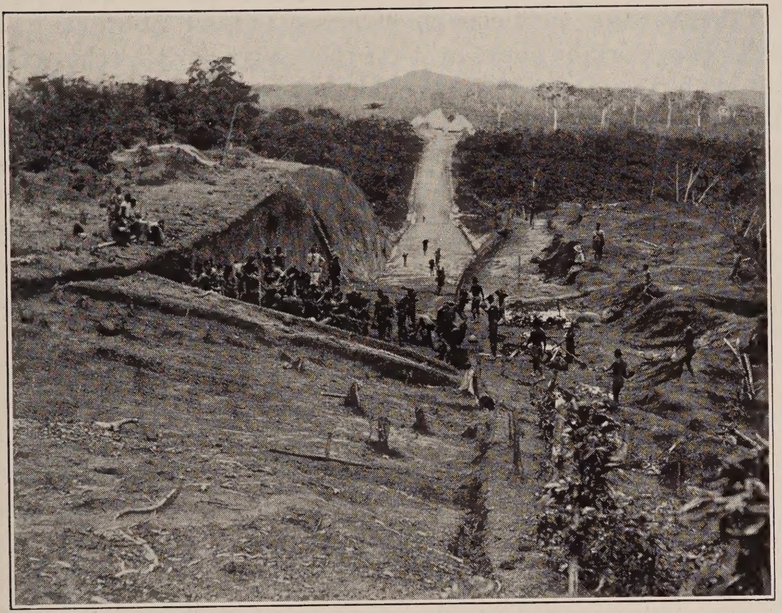
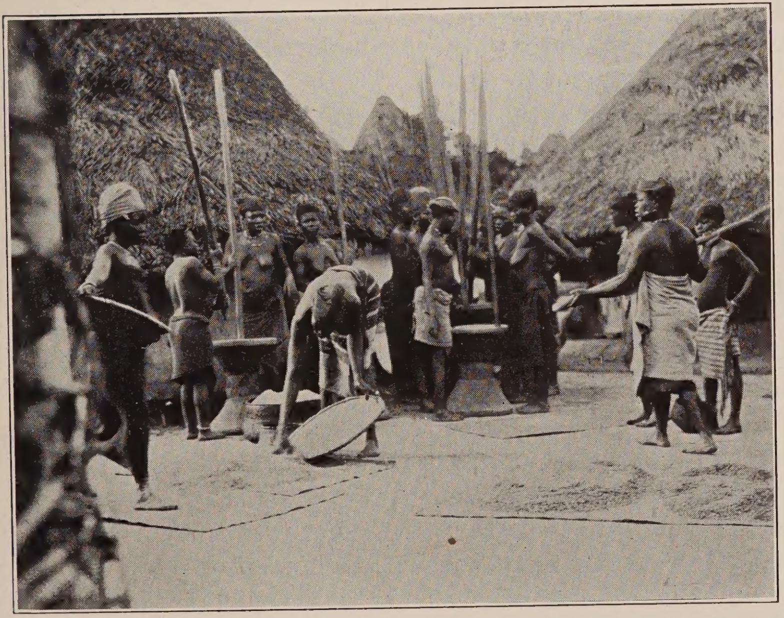
[1] Departmental Regulations, Liberia (1923).



No. 73. — Road near Tappi Town ending in a forest



No. 74. — Women preparing rice from the government farms

pound the rice with long poles in large wooden mortars, and though the sweat pours from their bodies, they constantly chant at their laborious task. If they come late to their work or pause in it for too long a period, they receive several lashes with a whip over their bare shoulders from the soldier who walks among them. Nevertheless, they are usually very docile and make little audible remonstrance against this oppression. The rice, after threshing and winnowing, is, according to their statements, turned over to the District Commissioner. The women receive no pay for the work, nor are they furnished with food.

According to the regulations, the natives in the interior must also supply labor for the roads. Before the World War, there were no roads whatever in the interior of Liberia and practically all communication was by trail. Since the war the Liberian Government has attempted to construct roads on an extensive scale in different parts of the country. Yet, at the time of our visit there was only one road extending into the interior of the country from Monrovia along which an automobile could be driven. This road ran from Monrovia to White Plains, a distance of some thirty miles. Road construction, however, is going on in the interior in a number of districts, and at times we encountered several hundred men engaged in the work. Such roads, however, rarely connect even one village with another. Frequently they end in a swamp or in a forest. These bits of unconnected highway, not properly graded, and without connecting bridges, are from time to time being washed away by the heavy rains, so that a force is kept at work intermittently repairing the same section of the road. The men are not supplied with the necessary tools to carry on the work satisfactorily. Sometimes a force of several hundred men were furnished with only two picks or only one or two spades. Of the rest, some used sharpened poles to dig holes, others had little paddles made of trunks of trees, with which to pack the clay, and others still had small wicker baskets which they carried on their shoulders and with which they removed the earth from place to place. The laborers work under the direction of the soldiers all day, chanting as they work and in rhythm with the beating of drums. According also to their statements, they receive no pay and are compelled to furnish their own food. Under one ruling of the government such labor may be requisitioned for a period of nine months.[1] During the three remaining months the laborers are left free to cultivate the farms.

Recently the People's party in Monrovia, although expressing approval of the development of roads, opposed the "method of using the aborigines as laborers without food, pay or the supply of tools to work with." Another statement was published in 1927 to the effect that the government had forced the natives "to work the roads without tools, food or pay; that on road work they were unjustly and excessively fined for the slightest breach of regulations under which they worked; that the Chiefs have had to pay heavy fines in rice and live stock whenever the required quota of men were not furnished; that the towns were required to furnish for travelling messengers, officers, soldiers, commissioners, in short, a host of petty officials, food and shelter and every luxury which was to be had, and that for such services there had been no compensation whatever; that the paid soldiery were permitted to pillage the towns through which they passed; that they, the uncivilized elements of the country, were admitted to no rights which the privileged officialdom was bound to respect."

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[1] See Liberian Gazette, Aug. 31, 1925; also Buell, *loc. cit.*, vol. II, p. 749.

Some Liberians have prophesied that a revolt would occur among the people of the interior unless the demands of the government were modified; however, since the interior tribes have few if any firearms, they are in no position to make any serious resistance.

As has already been said, the hinterland is not represented in the Liberian legislature, and only by paying for the privilege can a tribe send a referee to Monrovia to *watch* legislative proceedings.

IX

AGRICULTURE, FARM, AND FOREST PRODUCTS

We have already pointed out that the temperature and rainfall of Liberia give rise to an unusually luxuriant vegetation, and that the country is largely a forested one; and also that the most important productions are agricultural in character. In preparing the forest land for farming, the men first cut down the larger trees, brush, and undergrowth, leaving the stumps of larger trees in the ground. For this work they generally use the machete, a sword-like knife often three feet in length, with a sharp, broad blade. Sometimes they have adzes and occasionally a saw. The clearing is made usually in January and February, since in these months the weather is relatively dry. After a short time, when the slash is dry, it is burned. Such logs as do not burn are then broken or cut up or moved aside. Next the women begin to prepare the soil for planting by mixing it with the ashes of the burned vegetation. They have no plows or spades, but they employ a few hoes, the heads of which are made either of iron or wood. They also use sharpened poles for digging up the earth and in planting. The ground is prepared ready for sowing when the rains begin early in April. For collecting the crops the women have a number of small knives, but no scythes. They do all the farm work, planting, weeding and harvesting. It is customary for them to leave their villages very early in the morning, often accompanied by their young children who are sometimes taught to frighten the birds away from the crops. Occasionally they remain all day at the farms, but in other instances they return to the villages before the great heat of the day at noon, to cook. One sees many abandoned farms in the interior, which are spoken of by the natives as "dead farms." As they have no system of manuring, the land after one or sometimes two crops, is not tilled again, but is allowed to be overgrown by weeds and other secondary growth. After several years the land is again burned over, and of course is somewhat enriched by the ashes.

The prevailing crops are rice and mandioca or cassava. The rice is of the mountain variety and of good flavor. It is known as *manihoro*, and has a slightly blackened husk. It is said to have been introduced into the country by the Mandingoes. There is also a red variety in the interior, and, particularly nearer the coast, there is a white variety with larger grain. Mandioca or cassava, a euphorbiaceous plant with abundant latex, is found growing about almost every village. It constitutes one of the chief foodstuffs of the aboriginal tribes. Two varieties of Manihot, *M. utilissima*, are found in Liberia; the first or sweet variety, is so-called because its roots can be eaten raw; the other, contains in

No. 75. — Clearing of forest for rubber cultivation, Firestone Plantations

No. 76. — Clearing after burning

its tuberous roots a small amount of hydrocyanic acid which, as it is poisonous, must be got rid of by scraping and thorough soaking.[1]

In preparing the mandioca for food the roots are first pared of their outer rind, and then boiled until quite soft (No. 337). They are often mashed into a thick paste in a wooden mortar. The paste is then rolled into balls which are cooked again, often in palm oil. The soup thus formed, often seasoned with peppers, is eaten with spoons. On account of its glue-like consistency the mandioca paste is swallowed without masticating.

In addition to the two principal crops mentioned, eddoes, plantains, Indian corn, beans, peanuts, sweet potatoes, and sugar cane are sometimes raised. In some places small amounts of coffee, cotton, and tobacco are found. Sometimes millet is planted on the edges of the rice fields. In a few spots in the eastern part of the country, a small amount of cacao and occasionally oranges of fair quality are raised. However, the aboriginal natives do not grow anything in quantity. When questioned why they did not raise more, they almost invariably replied that they only raised enough for their own needs, since any surplus was always taken away from them by the authorities. Why, they asked, should they work for others?

Once a week the women collect the produce from the different farms and take it to market. In certain sections of the country market day is the most important in the week. An open place on the edge of the forest is set aside as the market place. The rules of the market are strict, no one may begin to barter or trade until all the wares and people from the different villages are assembled, and until the chief of the market gives a signal that the market is open. Then very active trading and much violent discussion and confusion prevail for a number of hours. Objects are directly traded or are paid for sometimes with loaves of salt, with heads of tobacco, or with twisted thin iron rods about a foot and a half in length, which have all more or less fixed value as currency. The Mandingoes are the cleverest traders. From across the border of French Guinea, they bring pieces of cloth of bright color and cheap cotton prints for clothing which they exchange particularly for kola nuts with the other Liberian tribes. These nuts they take or send over the Liberian border and dispose of at a higher price in the interior of French Guinea. The Mandingoes also sometimes pay for kola nuts and other agricultural products in silver, which later finds its way into the hands of the government in payment of the hut tax.

The food of the Liberians in the interior is mainly vegetable; rice, cassava, and yams constitute the staple articles of diet. They are usually steamed or boiled, often mixed with palm oil, and are served in large wooden bowls. Sometimes any meat procurable is also mixed with the vegetables. Maize is also grown and eaten in a few places, and okra, eddoes (Colocasia), sugar cane, plantains, and peppers also form occasional articles of diet. Many of the fruits

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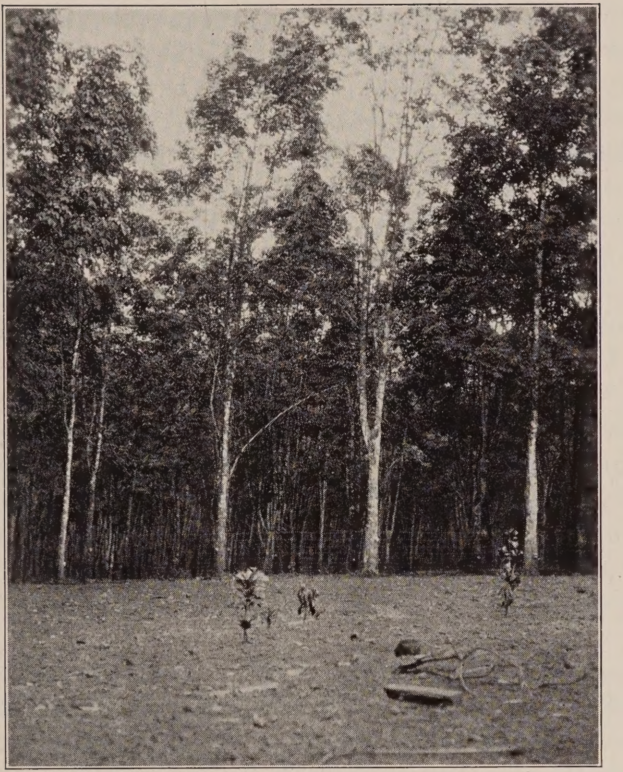
[1] Marquand (Bull Soc. Path. Exot. (1928), XXI, 879) has recently reported two cases of fatal asphyxia from insufficiently dry mandioca. A young Malagasy couple made a pile of fresh mandioca in their hut, went to bed and were found dead next morning. The autopsy revealed signs of asphyxia. White mice placed in a closed space with some of the same mandioca also succumbed.



No. 77. — Firestone Rubber Plantation, Mt. Barclay

No. 78. — Native rice farm at Gbanga

mentioned as growing about Monrovia are occasionally found elsewhere near the coast. Sometimes rice or millet is parched and ground into a flour, which is used particularly in palm oil soup. Palm cabbage and a sort of spinach made from various leaves, particularly *Portulaca*, is sometimes eaten. The sweet banana does not constitute a staple article of diet in the interior of Liberia. No large banana plantations were found, but in the northeastern part of the country, particularly near Tappi Town, small groves of excellent bananas were seen. There is apparently no reason why the banana industry should not flourish in Liberia. No banana disease was noted in the small banana groves examined. The tobacco grown in small quantities in the vicinity of a number of villages, is not only smoked but sometimes used as snuff.

In addition to the articles of diet already mentioned, the natives in the interior also eat a number of wild fruits. As these fruits, however, are not found in very great abundance in most neighborhoods, and are not gathered in quantity, they constitute rather an occasional than a staple article of diet. Among them, the species which have been identified by Dr. Linder, the botanist of the expedition, are:

Anona senegalensis, a low tree or bush which produces oval, rather rough dark red fruit.

Chrysobalanus orbicularis, another bush from ten to sixteen inches high, which gives rise to similar red fruits, and of rather insipid or slightly acid flavor.

Aframomum sp., a member of the ginger family, is more often eaten. This plant forms dense thickets, and at the base of the long fronds occur the rounded tapering orange-colored fruits. The fruit has a highly aromatic flavor, but is coarse and fibrous.

The fruit called by the natives the "monkey plum" is produced by a species of the Rosaceae, *Parinarium macrophyllum* (No. 130).

The berries of a melastomaceous plant, *Tristemma incompletum*, pink in color, and about one-half inch in diameter, are also frequently eaten for their sweet acrid taste.

The *Bussea occidentalis*, a member of the Leguminoseae, is a tree which grows to a height of eighty feet. It produces masses of rich yellow flowers which make it a striking sight in the forest. The flowers produce reddish pods that contain seeds eaten especially by the Kpwesi people.

Randia sp., a bush some seven feet tall, has a fruit with a flavor much like that of cranberries, less tart, but still of an acid quality.

Hibiscus esculentus is also a species of which the young fruits are eaten. The tree *Ricinodrendron* sp. also produces a fruit, the kernel of which is eaten. The husk is removed by boiling and then cracked, and the kernels are toasted and salted. This nut is very oily.

Artocarpus incisa (No. 133), the breadfruit tree, a low tree, also gives rise to a fruit which is eaten by the Americo-Liberians and local Mandingo people, but rarely by the Vai. This tree grows particularly in the coastal region.

Xylopia vallotii, a large spreading tree about forty feet high, produces fruit which is eaten particularly by the Kpwesi tribe, and which is called "sibi."

Many leaves are also eaten as vegetables. One of the most important is the vine *Ipomoea*, the thick fleshy leaves of which are used as a green particularly by the Vais.

The pepper, *Piper guineensis*, is used by the natives especially to flavor rice. It grows chiefly on the trunks of the higher trees. Several species of *Capsicum* are also frequently employed in cooking.

Among the vegetables consumed are two species of *Solanum*, one of which is eaten frequently as greens; the other producing a fruit like an immature eggplant.

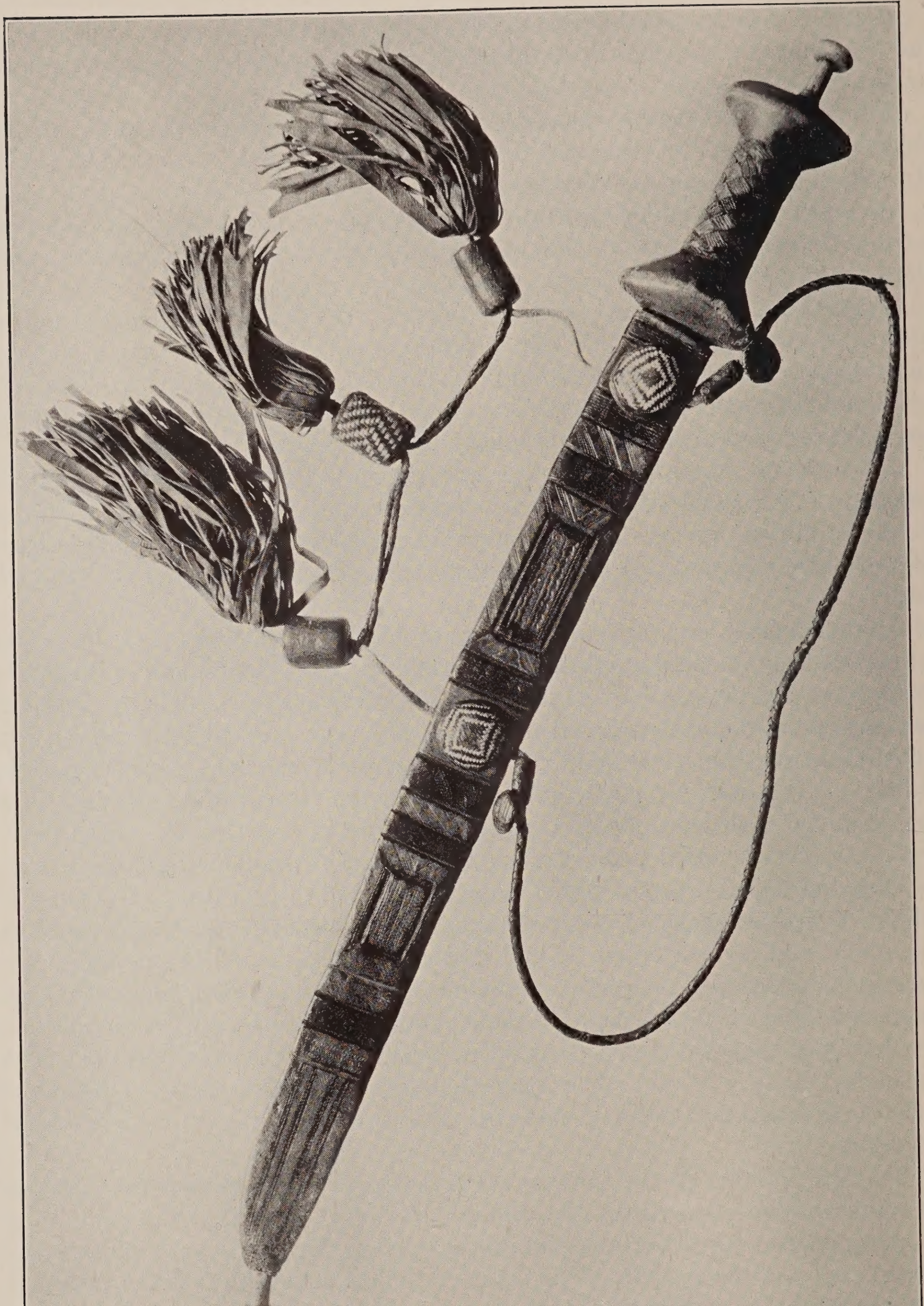
Nearer the coast several species of *Colocasia* and the *Ipomoea batatas* (sweet potato), a species of yam, as well as *Hibiscus esculentus* and a small tomato, *Lycopersicum esculentum*, are all cultivated in the gardens and eaten. The kola nut, *Cola acuminata*, also grows in some localities in a state of semi-cultivation, and is widely partaken of for its mildly stimulating and tonic effects.

Tetracera potatoria, known as the water tree, is found in most parts of the country. It is a low tree or shrub sometimes climbing upon other trees. When the stems are cut across, an abundant watery sap gushes forth, which is clear and tasteless, and which is often drunk by the natives when water is not available.

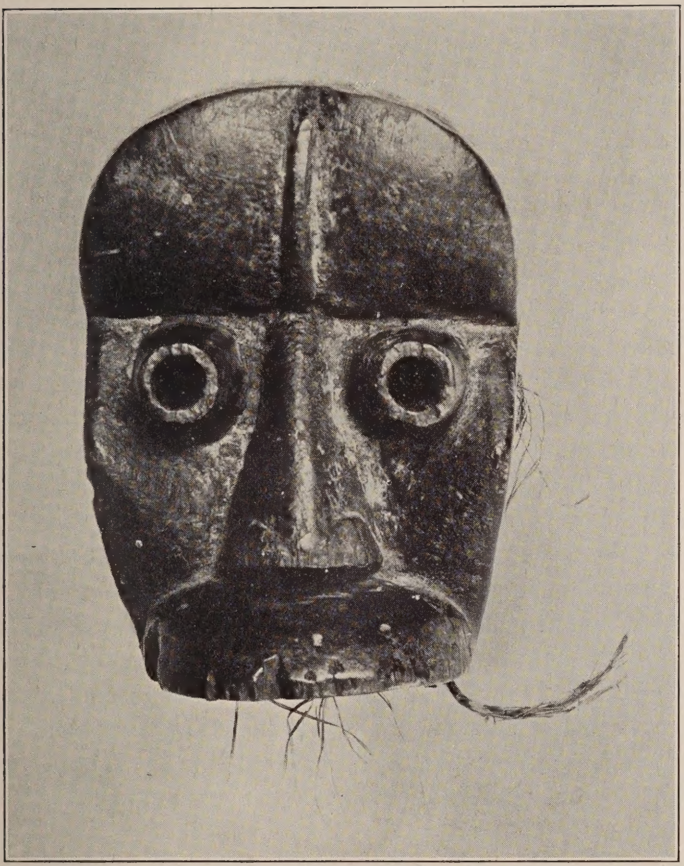
Animal food is scarce in most parts of Liberia. Chickens and ducks are found, but only in small numbers around many of the villages, and in the larger towns there are often a few goats, which are eaten for food. The milk of the goat is apparently not partaken of; sheep are very rare, and the scarcity of cattle has already been referred to. Apparently for economic reasons the natives seldom kill the oxen for meat, and only when the animal dies from injury or disease is the flesh consumed. On rare occasions in some of the towns bush-cow meat (forest buffalo, *Bubalus*) is seen in the market for sale, often with the skin and hair left on, in which state the meat is often eaten. The meat of duikers and occasionally of other antelopes, and of monkeys is even less often obtainable and seldom eaten by the natives. Among some of the tribes the scarcity of animal food no doubt is sometimes a great temptation to cannibalism. Elephants—and indeed game animals generally—are now very scarce and are found only in very few regions, and there is comparatively little hunting. Fish is a favorite article of diet when it can be obtained from the rivers by fish traps or nets. Smoked and salt fish, however, often makes its way in from the coast in trading.

Among a number of the interior tribes totemistic customs prevail. Among the totems which members of the different tribes may not eat are said to be the chimpanzee (called baboon), the black *Cephalophus* antelope, monkeys and catfish, and also the python. The souls of the departed are in some instances believed to live on in these animals.

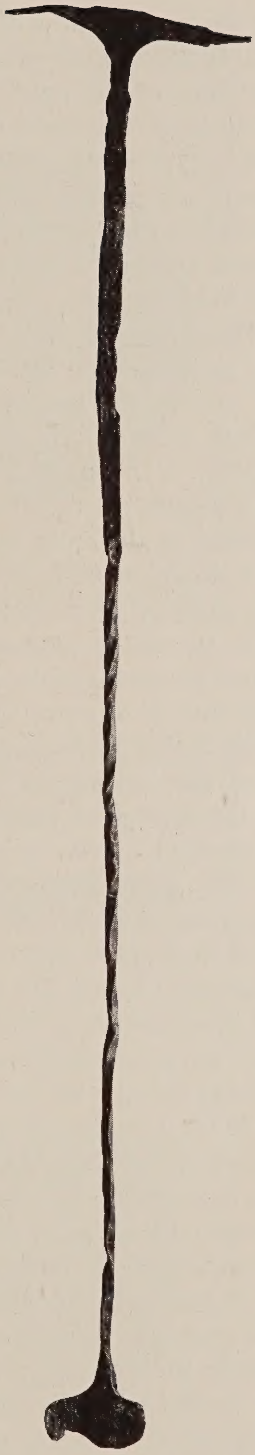
The chief meal of most of the inland people is eaten between five and six o'clock in the afternoon. Among some of the tribes another heavy meal is partaken of at noon, but little is eaten in the early morning. The woman takes her meal with the younger children after the men, on whom she usually waits.



No. 79. — Sword and scabbard of native manufacture, length 27½ inches



No. 80. — Mano devil mask from a deserted village between Gbanga and Tappi Town, used for devil ceremonies



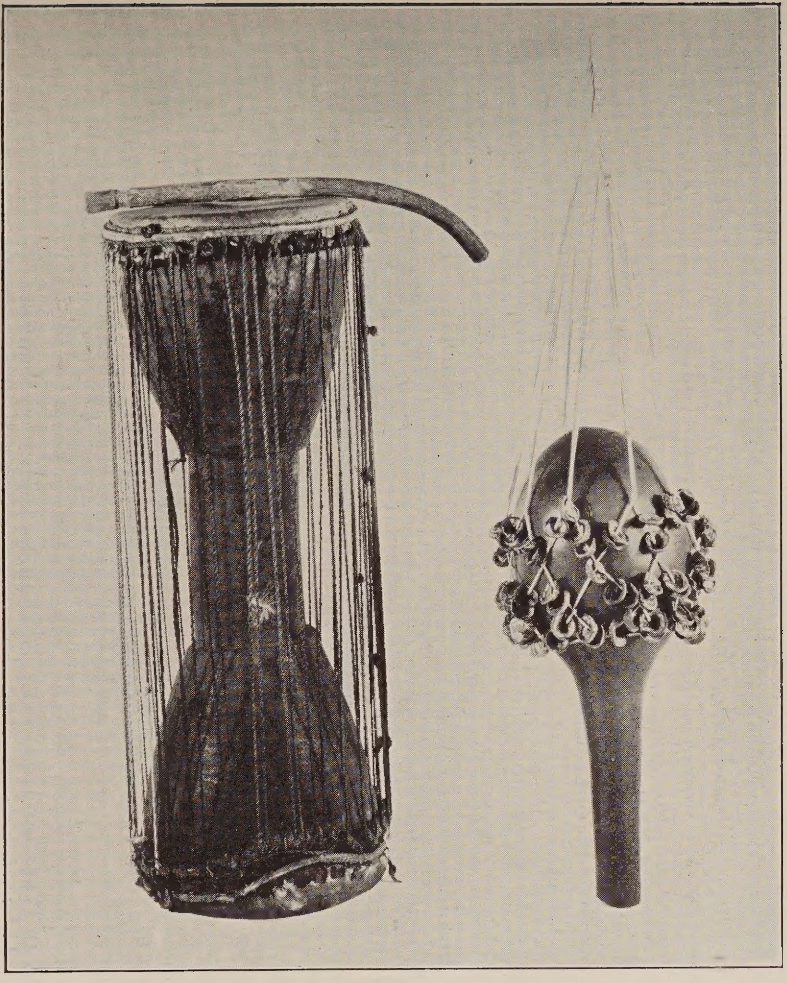
No. 81. — Mandingo money, length 19 inches

In sharp contrast with some other parts of Africa, the country is everywhere well supplied with clear, potable water. Palm wine made for the most part from the juice of the palm, *Raphia vinifera*, is freely partaken of. It varies greatly in alcoholic strength according to the length of time it has been fermented. Trade gin is everywhere sought after and highly prized. It is, however, practically never obtainable in the interior of the country and is only occasionally brought in for trading purposes. Rum is sometimes made from the sugar cane raised locally. Severe drunkenness among Liberians in the interior is very uncommon, but many of them become mildly intoxicated with palm wine. After drinking more than they should they generally lie down and go to sleep. They are rarely boisterous.

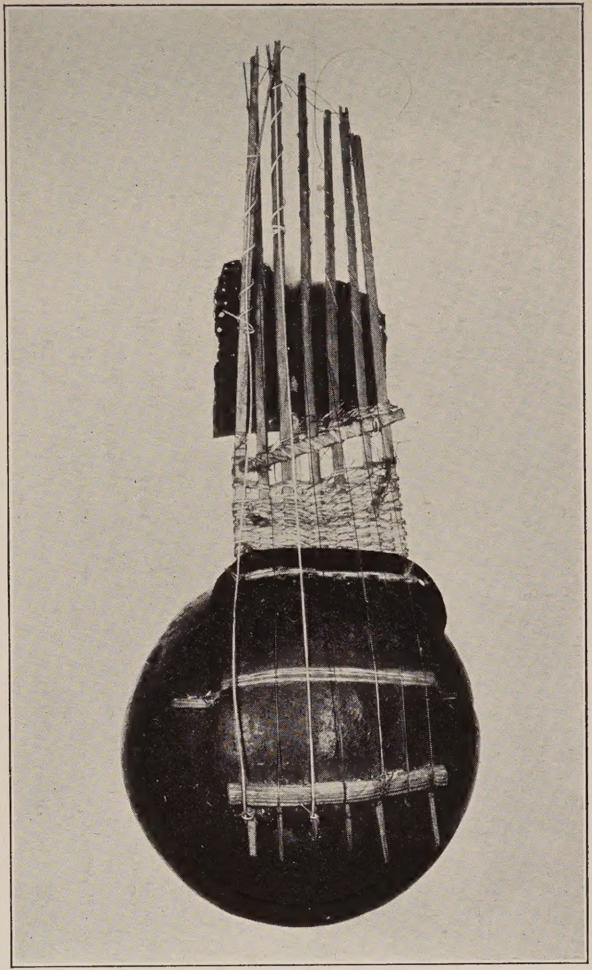
Among the most important forest products commercially is palm oil, obtained from *Elaeis guineensis.* This is perhaps the most valuable palm in Liberia. The nuts furnish palm oil of two varieties, Boechina and Nechina, so valuable in the manufacture of European soap, oleomargarine, etc. The kernels of the nuts also supply another oil, one of whose commercial uses is in connection with the preparation of a special kind of steel. Unfortunately, the palm oil as it occurs in the nut itself is perishable unless extracted shortly after the nut is gathered, and hence must be extracted at or near the place at which the nut is grown. As furnished by the native Liberians, it is usually rancid and thus is often of little value for export. However, the oil in the kernels is more stable and cannot easily be injured by the natives, and, since the oil from them need not be extracted in the country, they are exported directly to the European factories. The uses of palm oil for food have already been referred to. Palm wine is also sometimes obtained from this species.

The *Raphia vinifera* palm, which grows in greatest abundance particularly along the banks of a number of Liberian rivers, is another valuable product. It is used in building houses, the trunks for the framework, and the large ostrich plume-like fronds for the roofs. The bast furnishes the piassava fiber used in the manufacture of brushes and brooms. In 1925, 13,558,000 pounds of piassava fiber were exported, and 20,094,000 pounds of palm kernels, while only 672,606 gallons of palm oil were exported.

With the exception of rubber, the only important vegetable product exported which does not come from plants or trees that grow wild, is coffee. In the earlier days of the colony, coffee had become the chief crop of commercial value, and upon its cultivation and marketing, much of the prosperity of the country is said to have depended. However, owing to the fall in the price of coffee, consequent on the development and extension of the coffee industry in Brazil, and especially to the poor quality of the coffee furnished by the Liberian planters, largely through neglect of the plantations and poor care of the crops collected, the trade rapidly declined. Since planters found themselves unable to produce coffee at the former satisfactory profit, the plantations of the Americo-Liberians after a few years fell into neglect. Native laborers were paid less, or not at all, and finally refused to work. Moreover, it was found that government service was not only more lucrative but required less labor, and the coffee



No. 82. — Small drum and rattle of Jarquellis tribe



No. 83. — Favorite musical instrument of the Kpwesi people

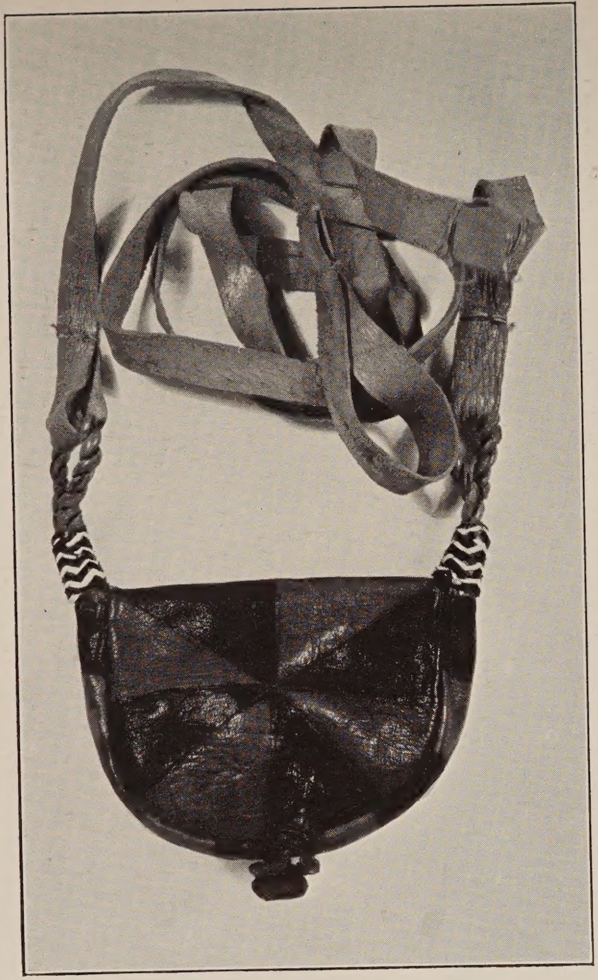
plantations fell into ruin. Recently, however, some revival of the industry has occurred, and Liberia can produce a very superior grade of coffee. In some regions numbers of the Gola tribe are attempting to raise it. However, the plantations that we saw were found to be in poor condition, badly kept, poorly worked, and neglected. The production of rubber is considered later in the Report (page 132).

The lack of success in agricultural activity in Liberia is due in part to the dislike or even contempt of the Americo-Liberians for manual labor, and in part to the restrictions which the Liberian Government has placed on commerce and particularly on trade with the aboriginal tribes in the interior. At different times the hinterland has been closed to all foreigners and at no time can one travel in the interior without governmental permission. The natives who wished to sell their agricultural products have been obliged to market them on the coast; so decided an obstruction to trade, that many natives consider it entirely futile to attempt to raise or to harvest crops for profit.

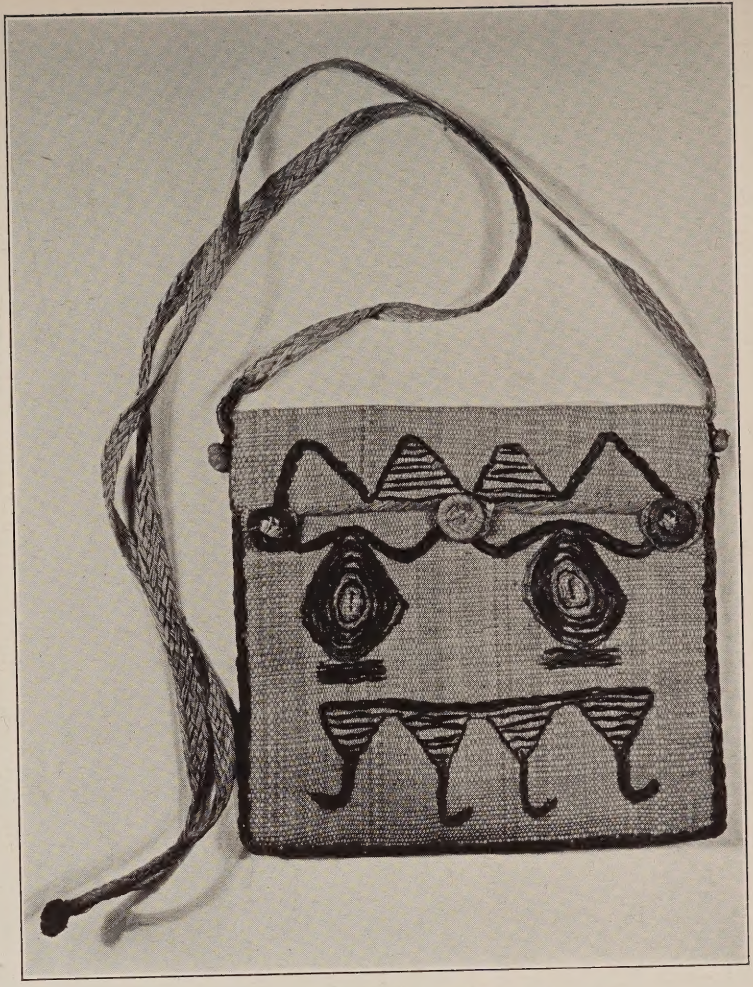
One of the chief reasons given for the Americo-Liberian dislike for labor is the fact that formerly such work was often performed by slaves. As a matter of fact the more important cause is the natural desire to avoid work whenever possible. Whenever feasible the Americo-Liberians have used aboriginal Africans for agricultural labor. Labor of this kind, however, if it is to be successfully employed, requires some direction and attention, fair treatment and some remuneration. Liberia should bloom as an agricultural country. It cannot do so, however, unless interest in the cultivation of the soil is aroused among the native tribes. Laborers must be treated fairly; they must receive pay for their service, pay which they may retain and expend upon themselves, and which will not be taken away from them by the authorities. If the greatest success is to be obtained, a better and more nutritious diet must be furnished to the laborers and they must be built up physically and their general health cared for. It is also important that they should have sanitary and medical supervision, treatment for their ailments, and better protection against contracting infectious disease.

Liberia could easily provide the larger part of the food which the inhabitants require. At the present time, however, much of the food is imported from Europe and the United States. In some years twenty-five per cent of the total of the imports have been foodstuffs. Thus, in 1924, of the total imports of $679,000 at Monrovia, foodstuffs amounting to about $172,000 were entered. Of this amount $22,000 was for fish, $5,000 for ham and bacon, $3,700 for biscuit, $11,000 for salted beef, $57,000 for rice, and $18,000 for sugar. There obviously is no good reason why rice and sugar or salt fish should be imported.

Industries and Articles Manufactured. The articles manufactured by the tribes of Liberia are of simple nature and of little value. The smelting of iron has gradually decreased in the interior, owing to the importation from the coast of various European iron implements of superior grade. Iron stone, however, is sufficiently abundant in some regions, and, as has already been said, is still smelted in furnaces, sometimes made of old termites' nests, which

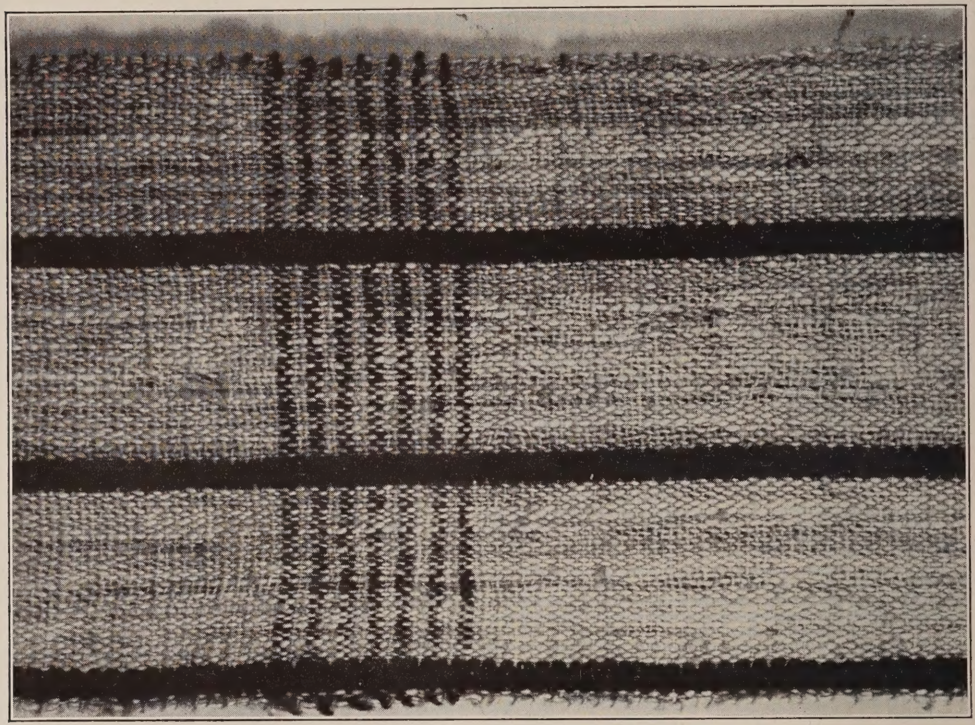


No. 84. — Leather bag of the Kpwesi tribe



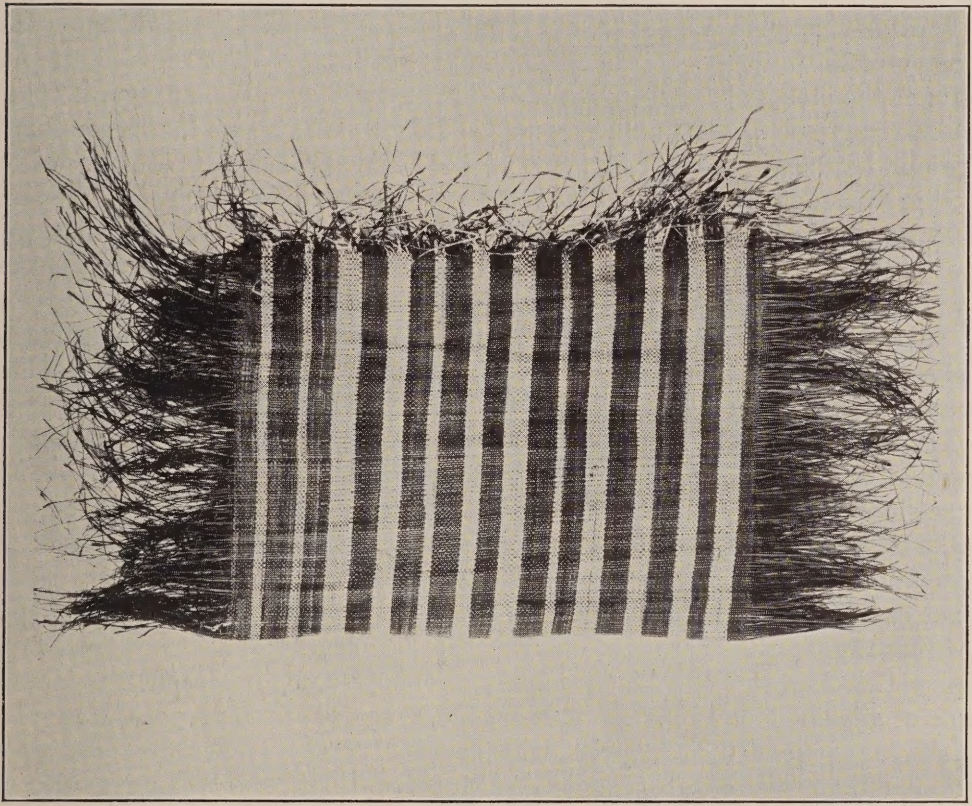
No. 85. — Fiber bag of the Gio tribe

owing to their clay and cement-like structure, are particularly suitable for the purpose. Such articles particularly as knives, arrows and spearheads, bracelets, anklets, rings, and heads for hoes are made. Some work is also done with silver, especially the manufacture of silver ornaments for women, hairpins, bracelets and rings. Small amounts of both silver and copper are imported for this use from the adjacent countries. The Mandingoes manufacture attractive articles of leather, such as scabbards for swords, sheathes for knives, belts, and basket covers. They are the most attractive articles that the natives manufacture. They are rare, however, and not easily purchased. Pottery is still made by a number of the tribes inhabiting those regions where suitable clay abounds. Along the coast the making of pottery has become a lost art. Here the inhabitants chiefly use imported iron pots and vessels of coarse earthen ware, and these articles are gradually finding their way into the interior. The women make most of the pottery. They mould the vessels of clay, dry them in the sun and bake them in red hot ashes from wood fires. Small vessels for individual use, and larger ones holding several litres, are manufactured. Gourds are often employed as receptacles. Cut in halves they are used as ladles or cups, or, cleaned out and preserved intact, are employed as bottles. Some of them are ornamented with black and white work and carved with various designs, particularly of animals. Somewhat skillful wood carving is done by the men. A great many spoons of various shapes and sizes are made. The wooden mortars



No. 86. — Liberian woven cloth

used in pounding rice and millet are hewn by hand out of solid blocks of wood with the machete or the adze. The bodies of drums and long wooden trumpets are likewise carved out of such blocks, and in some villages along the rivers, canoes are made by digging out tree trunks, which are brought to the required thinness by the use of the adze and of fire. Plates, platters, and bowls of all sizes are also made of wood, as well as stools and benches and the framework of beds. Small boxes for holding snuff and scabbards for knives are also made of wood, but combs are more often carved from bone or ivory. Masks of ebony or other hard wood, roughly resembling the human face, or of grotesque or conventional design, are also carved and used for the ceremonies connected with the devil bush. Small fetishes or idols are likewise carved out of blocks of wood. The Vai make calendars with small squares of wood, which they decorate with their insignia, and hang on strings. They use long decorated boards with short legs on which to play a game named *po*, which is somewhat like back-gammon. The Mandingoes construct a form of xylophone with crossed slabs of resonant wood, and make flutes of wood, also small drums and rattles. In fact, the handcarving of wood, although crude, may be said to constitute the most important artistic industry of the interior of the country.



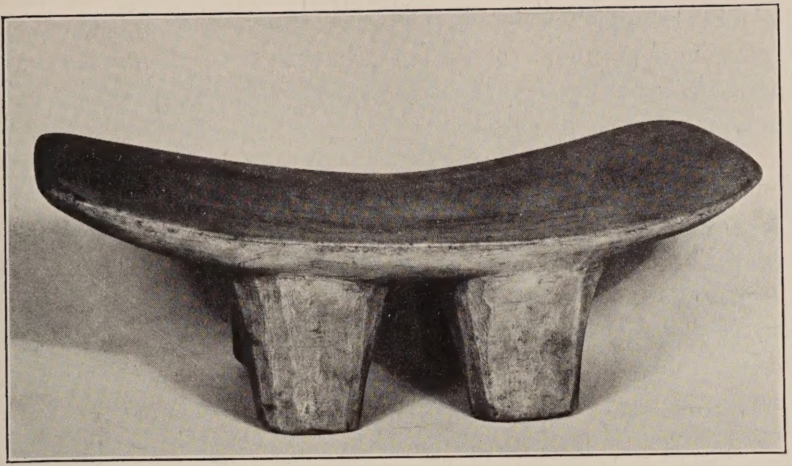
No. 87. — Liberian mat

Spinning cotton thread from cotton raised in the vicinity is practiced in many of the villages; the strands of thread which have been dyed blue with indigo or red with camwood, or, more rarely, yellow with annatto, are sometimes seen drying in the sun. The simple method of hand spinning of the cotton always done by women, has already been described. The weaving of the cloth, however, is done, not by the women who do the spinning, but by men in a clumsy loom constructed of poles in which the operator sits and uses both his hands and feet. As woven, the cloth is in narrow strips, which are later so neatly sewn together that it appears as if the cloth were woven in one piece. Blue and white striped cloth is the most common and apparently the favorite pattern.

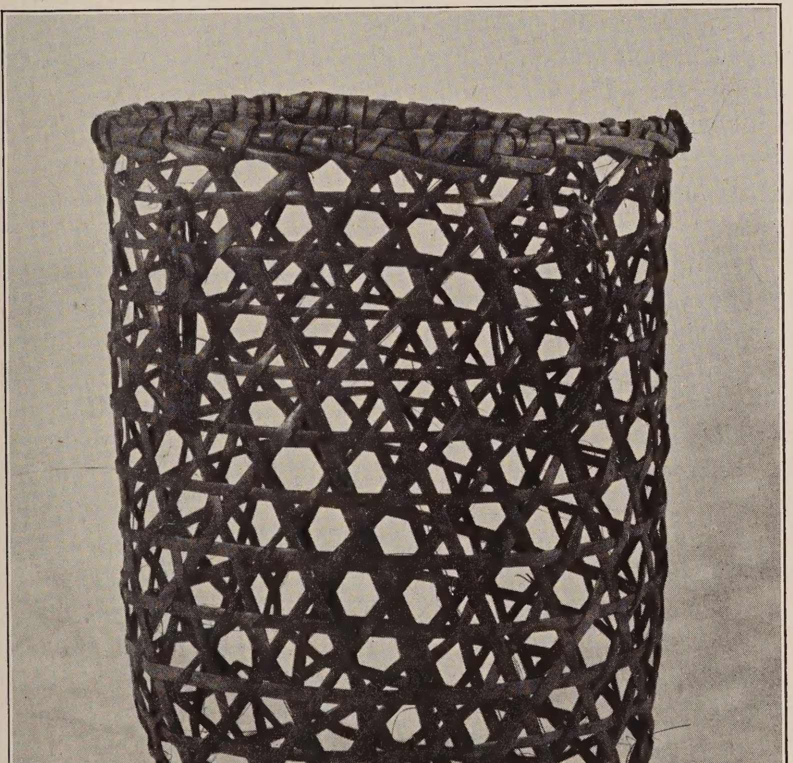
Plaiting and weaving other materials than cotton is another important industry of the interior. Mats are made particularly of the fronds or the filaments of the stems of *Raphia vinifera*, and are sometimes dyed different colors. Less rarely grass is used in making mats. Baskets of various sizes, hammocks, kinjas or hampers for carrying loads on the back and fish nets are also woven of palm filaments and fiber. Bark cloth is made and worn by some of the tribes, particularly those in the eastern part of the country. For this purpose the bast or inner bark, especially of the fig tree, is stripped and soaked in water and then beaten with wood and rolled into long strips. These strips are employed as G strings or loin cloths. Occasionally, though somewhat rarely, skins of small animals are used for the purpose by the Liberian tribes. Occasionally skirts of grass or palm fiber are worn by the women.

The respective activities of the men and women are rather definitely determined and with certain minor exceptions already referred to are on the whole similar among the interior tribes. As has been mentioned, the men clear the forest of the big trees by way of preparing the farms, and burn over the cleared area, but the women do all the farm work. Women, however, usually do not carry produce in heavy loads on their back but only comparatively light ones, usually on the head. In carrying the heavier loads the men frequently employ the characteristic *kinja*, a kind of oblong hamper attached to a stout frame of sticks (No. 122). In building the house the man prepares and mixes the clay or earth with water, fells the necessary trees and poles, does any woodwork required and frequently prepares the thatching; the woman carries the clay or earth, plasters the walls with it, makes the clay floor, and does the other earthern work necessary about the house. She also does the housework, the preparation of meals, the cooking, washing of dishes, the threshing of rice, the paring, pounding and preparing of mandioca, the preparation of palm oil, the manufacture of soap, the preparation of salt, the washing of clothing, the carrying of water and wood, the spinning of cotton, and occasionally she catches fish. In some of the tribes the men make canoes or fish nets or traps. They also collect palm wine or gather kola nuts, and indulge in fishing, and in hunting. Unless they are engaged in some discussion at the palaver house, they are frequently seen lying or sprawling about, resting during the day.

Fishing is not extensively carried on in the interior, and apparently no fishing is done there with hook and line. Most of the fish are caught in traps and baskets through weirs that are placed across the streams or rivers. Occasion-



No. 88. — Liberian stool



No. 89. — Liberian basket

ally in the more sluggish streams, fish are stupefied or poisoned, or, having been first attracted at night to the surface with a torch, are speared.

Hunting is not extensively practiced since wild game is so scarce. Small animals such as shrews, otters, mongooses, and antelopes are caught in trap snares or in springs or nets, and particularly in pitfalls and along the customary route of the animals to the water. Occasionally a heavily-weighted harpoon is poised over the path on a snare. Bows and arrows are now seldom employed. Guns generally of antiquated type, and spears, are used in hunting forest buffaloes, elephants, and leopards. Spears or lances are sometimes fired from guns. Leopards are generally first caught in traps and then shot. The natives usually hold and discharge the gun in a peculiar way, not placing the stock to the shoulder, but below and under the armpit. In hunting elephants, the particular aim seems to be to wound the animal severely in the abdomen and then to follow him until he falls or dies of the resulting peritonitis. Elephants have become scarce in Liberia and even the pigmy hippopotamus, the species which occurs there, is not common.

Rubber Production

For the production and cultivation of rubber the conditions are particularly favorable in Liberia. The wild rubber plants grow abundantly in certain areas, and the cultivation of the imported Para rubber (*Hevea brasiliensis*), has for a number of years been successfully practiced. In 1923 Mr. Harvey S. Firestone emphasized the unfavorable aspect of foreign rubber monopolies, and evidently influenced Congress to appropriate $500,000 to enable the Department of Commerce to investigate the possibilities of developing American-owned plantations of rubber and of other essential raw materials. He also directed attention to Liberia as a rubber-producing country, and sent representatives there to investigate the situation. The opportunities for the production of rubber in that country and the desirability of the United States' having an independent source of supply, were strongly emphasized in his book, "Men and Rubber." After having had the situation carefully considered in Liberia, Mr. Firestone entered into an agreement with the Government of the Republic [1] under the terms of which he was granted a lease for ninety-nine years on a million acres of the most suitable land, and another lease for a like period on a plantation of two thousand acres which was started fifteen years before and which was in full bearing. Arrangements were also entered into for the general public improvement of the country, such as the construction of port and harbor facilities, roads, hospitals, sanitation, lines of communication, and hydro-electric power plants. Mr. Firestone further states that for the last year his factories have been receiving shipments of rubber of the highest grade from the above-mentioned plantation, and that he believes "that we can build up Liberia through our own operations to a point where, in addition to being our great rubber source, it will also be a large market for American goods. This will be serving the people in a practical way." In the closing chapters of his book he writes:

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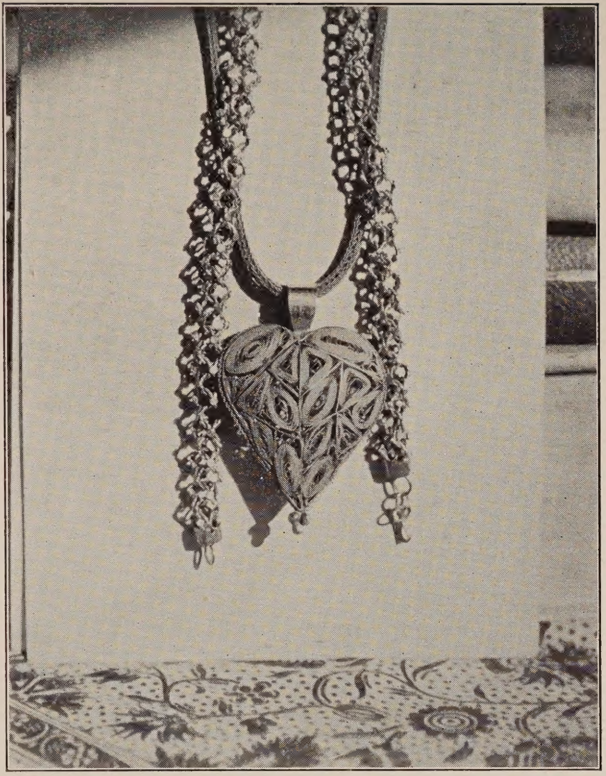
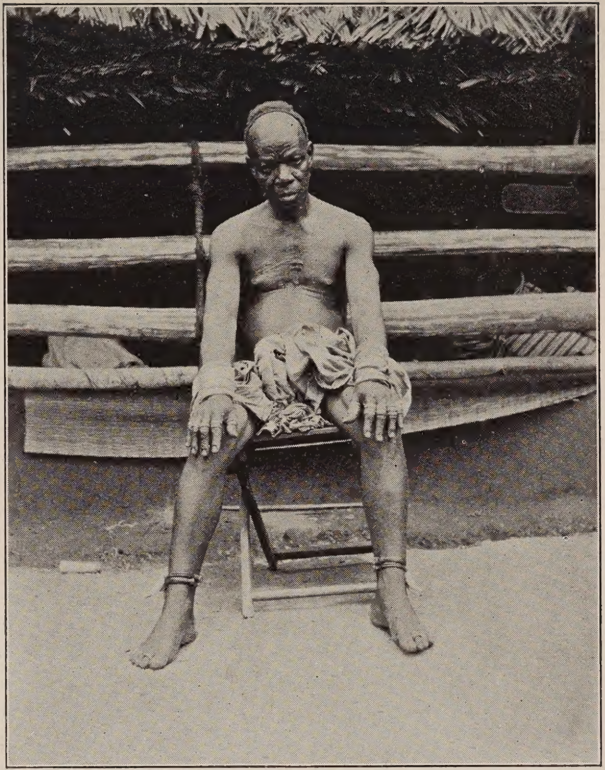
[1] Firestone, H. S.: "Men and Rubber" (1926), p. 268.



No. 90. — Vai pendant and necklace



No. 91. — Rings, bracelets, and anklets

"The greatest pleasure is in doing something to help others to help themselves. There is some small satisfaction in just giving away money, but the great satisfaction is in giving others the chance to be independent. For instance, the opening of Liberia or the Philippines would be worth more than a life's work."

The Firestone Plantations Company plans to develop centers in different parts of the country where the land is suitable for the cultivation of rubber and where labor is available. Roads are already being made and villages built at those centers. The company has also made it clear that it does not wish to prevent the native man himself from producing rubber on his own land and selling it to the company. Such natives as prefer to produce rubber in adjacent settlements will be encouraged to do so.

Through this development of the rubber industry by Mr. Firestone's representatives in Liberia, natives in the interior are being given the opportunity, apparently for the first time, to receive without government interference, not only regular compensation for their labor at a minimum rate of a shilling a day, but also opportunities to increase their general welfare. Not only are the authorities of the organization apparently alive to the advisability of treating labor well, but also evidently desire to improve the general conditions of living of the laborers. Plans have been worked out for the construction of model villages, equipped with sanitary kitchens, latrines, a water supply, and a hospital. Gardens are also being planned for each individual house. Stores have been established where rice and other foods and articles desired by the natives may be purchased at cost. The customs and habits of the natives are being carefully studied, and a trade school is being opened. Measures for child welfare and facilities for recreation are being planned for. The social advantages inherent in such plans are obvious, and Mr. Firestone's intention to improve conditions in Liberia, as well as successfully to produce rubber there, are unquestionable. Already, as a result of these activities, it has been said that Liberia has awakened from a half century of stupor. More money is in circulation than ever before, business has taken on new life, and a new era of prosperity has begun.

X

FINANCIAL CONDITIONS

It has been obvious not only to such foreigners as have carefully studied the situation, but also to the President and the legislature of Liberia, that the Liberian people have lacked the necessary capital, financial experience, and business ability to develop their country most successfully and advantageously, and that in these respects, they need foreign assistance and advice. The history of the country for the past seventy-five years has indeed demonstrated this need. Owing especially to scant production and to lack of education, experience and wealth among the inhabitants, and to laxness of financial administration, Liberia has led an impoverished existence. Today the per capita revenue of the Government is said to be the lowest of any territory in Africa.[1] Records of financial difficulties and scandals in public finance in Liberia have been frequent since 1864, and in 1871 it was necessary to authorize a foreign loan of £100,000. In 1906 a second loan of equal amount was necessary. By no means all of this money, however, found its way into the Liberian treasury and in spite of the two loans the country gradually became more and more involved in debt. In 1909 on the invitation of the Liberian Government, an American Commission appointed by the President of the United States visited the country to report on the general situation, with a view to extending assistance to Liberia, and enabling her to rearrange her disordered finances. After an extended investigation and much discussion, an arrangement for a new loan of about $1,700,000 was made with certain banking establishments in the United States, England, France, and Germany, and in connection with this loan an international receivership was established with an American as General Receiver, assisted by French, German, and British receivers. The loan was secured on the Liberian customs revenue. The General Receiver was also entrusted with the duties of Financial Advisor to the Liberian Government. The receipts of the Department of Customs, and the rubber taxes, together with one or two less important sources of revenue, were assigned to this receivership for the payment of the interest on the loan and for the establishment of a sinking fund for the ultimate extinction of the debt. The residue of the receipts was to go to the Republic. The Liberian Government agreed to maintain a "frontier force" (a military organization), and to request the President of the United States to designate trained military officers so to organize it as to secure order in the community.

This loan, however, only temporarily placed Liberia in a favorable financial position. In 1915 the country, largely on account of conditions brought about by the World War, and of the reduction in customs receipts, was again near bankruptcy. Not only was the interest on the loan not paid, but the amount owed to the Liberian frontier force had greatly increased. The Liberian Government issued bonds to the amount of some $215,000 to cover this indebtedness, yet at the end of the World War it owed nearly $91,000 to the officers and men. The British Bank of West Africa finally had to come to the aid of the Government to which it gave a temporary loan of some hundred thousand dollars. In September 1914, the American Minister in Monrovia cabled the State Department that financial assistance for Liberia was imperative and in the same year the United States Treasury established a credit of five million dollars in favor of Liberia, under authority of the Second Liberty Loan Act of September 24, 1917, which empowered the President to place credits at the disposal of the Allies for the purpose of prosecuting the War. This loan to Liberia was conditional on the inauguration of a certain program. It converted the administration of the International Loan into an exclusively American receivership which would control internal as well as external revenue, and provided that American citizens should act as commissioners to establish and maintain a just and equitable administration of the hinterland and to preserve order therein. The Secretary of State of Liberia accepted this loan, but obviously it was not popular with the people or with the Government, particularly the clause about maintaining a just and equitable administration of the hinterland.

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[1] Buell: *Loc. cit.*, vol. II, p. 795.

The Liberian Commission appointed to arbitrate on the question of this loan and its terms did not arrive in the United States until March 6, 1921, two days after President Harding's inauguration, and on July 2nd of that year, when the war was declared at an end, it became necessary for the President to obtain the consent of Congress to any loan. Secretary of State Hughes wrote to the Senate suggesting a resolution approving such a loan, and President Harding also wrote to the President of the Senate that the loan was an obligation which the executive could not discharge without the approval of Congress. Secretary Hughes further declared that the loan was a moral obligation upon the United States. Appearing before the Committee on Ways and Means of the House in 1922, he said: "I came to the conclusion that as we had notified Liberia that this credit was open, as we had asked the British and French to retire and to make no further plans, and had assured them that we had an American program here and did not want or desire anything to stand in the way of carrying out that American program, after Liberia had lost her reasonable opportunities in the meantime to enter into negotiations with others, it was our duty to go ahead and make our word good. I thought that to default on one's word in such a case would be regarded among business men in private affairs as very sharp practice and I felt that it was our duty to go ahead, and I so informed the President." [1]

In spite of this favorable endorsement from our State Department and the

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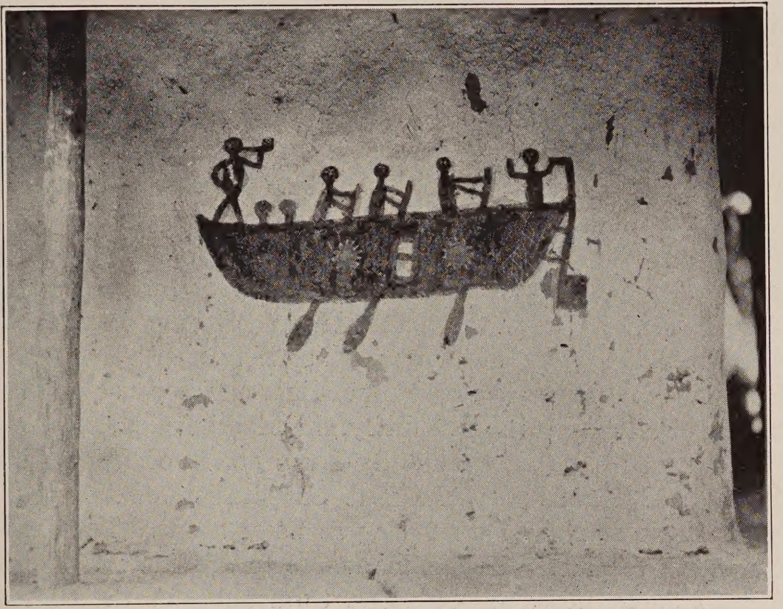
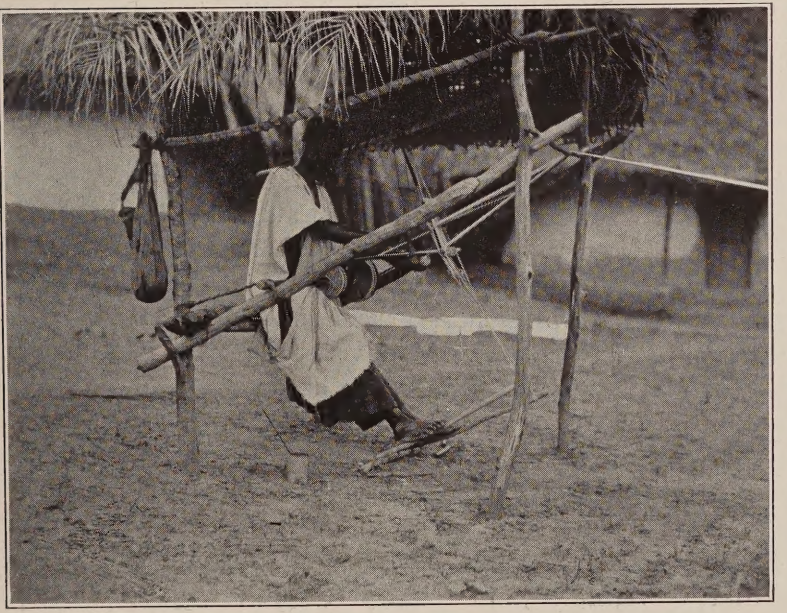
[1] Credit for the Government of Liberia, Hearing before the Committee of Ways and Means, House of Representatives, Part II, p. 145.



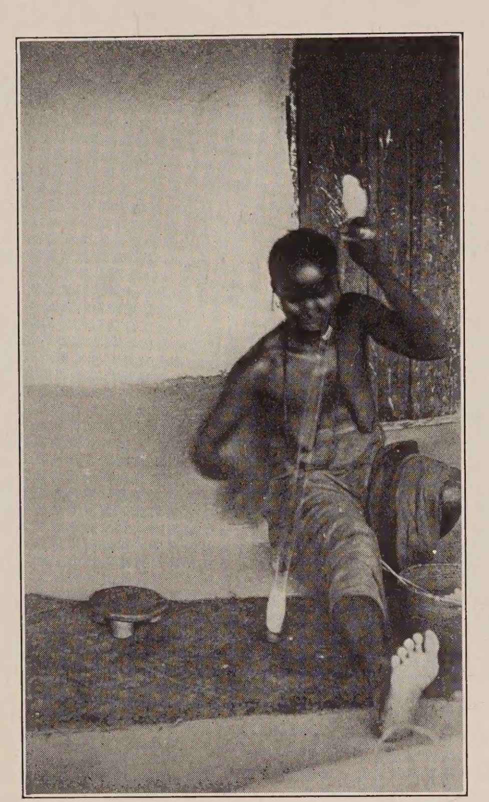
No. 92. — Mural decoration, Nickabo



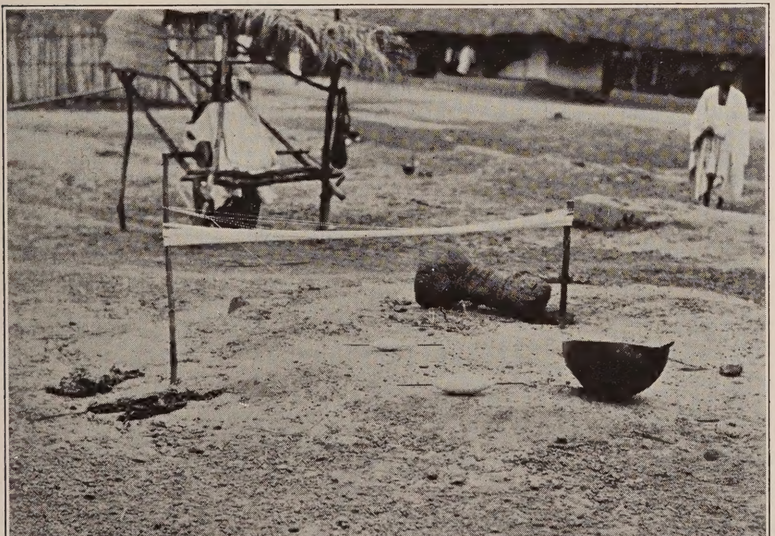
No. 93. — Weaving of cotton

favorable report of the Committee of Finance upon it, the bill for the loan failed to pass the Senate. Apparently some senators feared that the loan would prove profitable to banks which had purchased depreciated bonds that under the new arrangement would be redeemed at par.

Although the failure of this loan was a great blow to Liberian interests, nevertheless, owing to the planting agreements between Mr. Firestone and the Government in 1925, the financial condition of Liberia began to improve. However, it was quite clear to the Liberian Government that, if any favorable economic development of importance in the country was to occur, additional foreign capital was necessary. Indeed, the necessity for an additional loan was apparent to all who were well informed on Liberian conditions. At the time when the Liberian Government was still seeking such a loan, the Firestone rubber concessions and agreements were pending, and because of this prospect of real economic development in the country, the Liberian Government succeeded in obtaining a loan providing eventually for a credit of five million dollars to be extended to Liberia by the Finance Corporation of America, with the National City Bank of New York acting as fiscal agent. The reasons given by the Liberian Government for this loan were to provide for the adjustment of the country's outstanding indebtedness, to arrange for the construction of certain public works, roads, bridges, and wharves, and to develop harbors and communications, to encourage agriculture, to create a sanitary organization which would include the establishment and maintenance of hospitals, to build schools and encourage education among its people, to develop and maintain a frontier force, and generally to benefit the country economically. The final terms of the loan as ratified are regarded by the Liberian people as being much more favorable to the country than the terms of the United States Government loan offered in 1919. Under the terms of the new loan the number of American army officers to be appointed for the purpose of assisting in the reorganization of the frontier force is reduced to two. Although Liberia regards this reduction as a victory, it is obviously unfortunate, for the history of the frontier force has been most unsavory, and the Liberian Government certainly needs all the capable foreign assistance that could be obtained in order to render this organization more creditable. However, the loan provides for a Financial Advisor for the Government of Liberia, to be designated by the President of the United States; an Auditor and Assistant Auditor who are to be appointed by agreement with the Fiscal Agent; a Supervisor of Customs; and, what is especially important, a Supervisor of Internal Revenue. Thus as a result of the new loan Liberia is to have the advice and supervision of seven Americans in all. The final ratification of the loan has brought general satisfaction, not only to the Liberian Government, but to all persons truly interested in the welfare of that country. Taken in connection with the Firestone agreements, it gives a unique opportunity, not only for the financial rehabilitation of Liberia, but for the economic development of the country and for the improvement of the general condition of its inhabitants.



No. 94. — Spinning of cotton, hand loom



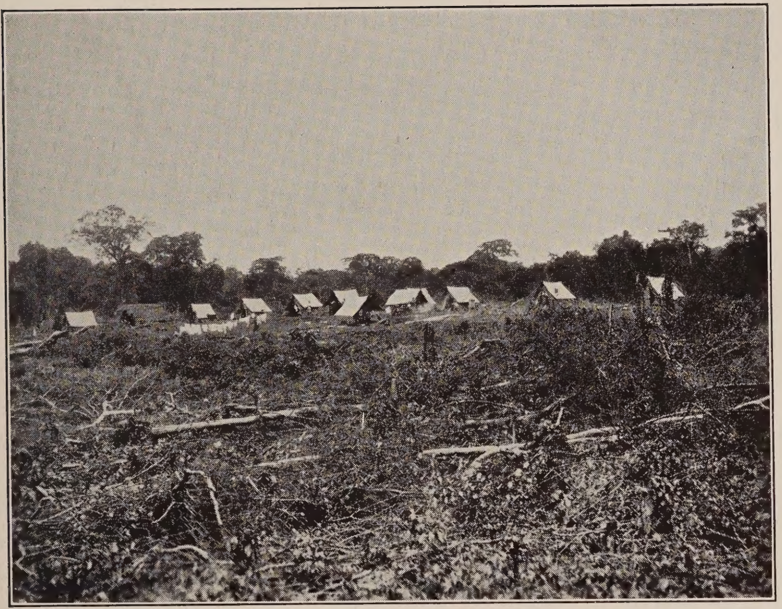
No. 95. — Cotton thread ready for dyeing with indigo

XI

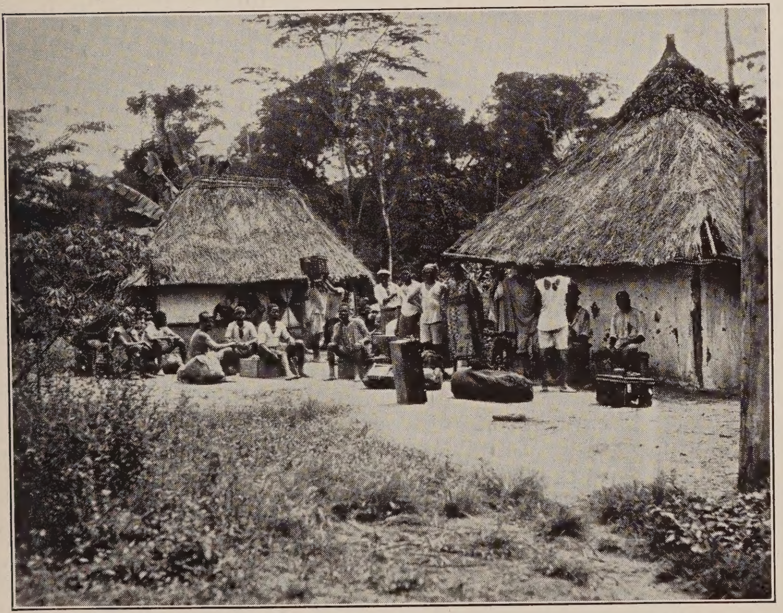
TRAVEL IN THE INTERIOR AND CARE OF PERSONNEL

As there were no completed automobile roads anywhere in the interior of Liberia, all our travelling with the exception of one journey made by canoe and launch up a partly navigable river, was done on foot, and our baggage and equipment were carried on the heads or backs of porters, in loads not exceeding sixty pounds in weight. Heavier loads were strung on poles and carried on the shoulders or heads of two or even four men. In some regions it was found advisable and even necessary to reduce the load considerably. The men usually performed very well marches of five or six hours. In some parts of the country, however, it was necessary to shorten the day's march and in others to lengthen it. Among some of the tribes women largely replaced the men as porters. We did not at any time make use of chairs. None of the members of the Expedition were ever carried; we saved all of our native man power for the transport of luggage and supplies and for other work of the Expedition. All the porters proved to be honest; that is no man ever absconded with his load. Numbers of them ran away at different times, particularly when in the forest and isolated districts, but they always left their loads in plain sight either on the trail or near it where it could later be recovered. We had at times as many as three hundred and fifty loads, because in going into an unknown country we had to carry not only our scientific and camp equipment, but also food supplies. It was also necessary to carry some five thousand dollars in silver coins, shillings, and six-pence pieces, but although the porters knew that they were carrying silver, they never either lost or stole any of it. The tobacco which we carried and which was also used as currency, was probably a greater temptation for them than the money.

It was customary for the porters to carry either from village to village, or within the territories of their own tribe. They would seldom go further than the first village beyond their own boundaries. This was obviously due both to custom and to fear that they would be detained or retained by the neighboring tribe. There was no active and open hostility between any of the interior tribes, but even when at peace, they usually associate little with one another, and if a stray outsider is caught in a village away from his tribe, he may very likely be held by the chief as a slave until ransomed by his own people. When the porters travel in a body they apparently feel more courageous than when one or two are alone and, as stated, will often carry to the first village beyond their borders. However, they never tarry long in the strange village and in some districts they start back immediately. Each group of porters from a



No. 96. — Our first base camp near the Du River



No. 97. — A relay of porters resting on the march at Lenga Town

different village or section is under the direction of a local head man, who of course is under the orders of a head man for the entire column.

It was necessary of course to change interpreters in the different villages. Although we had in our personnel and among our servants from the coast men who could speak English and several dialects, no one of them could speak or understand all the languages of the different tribes.

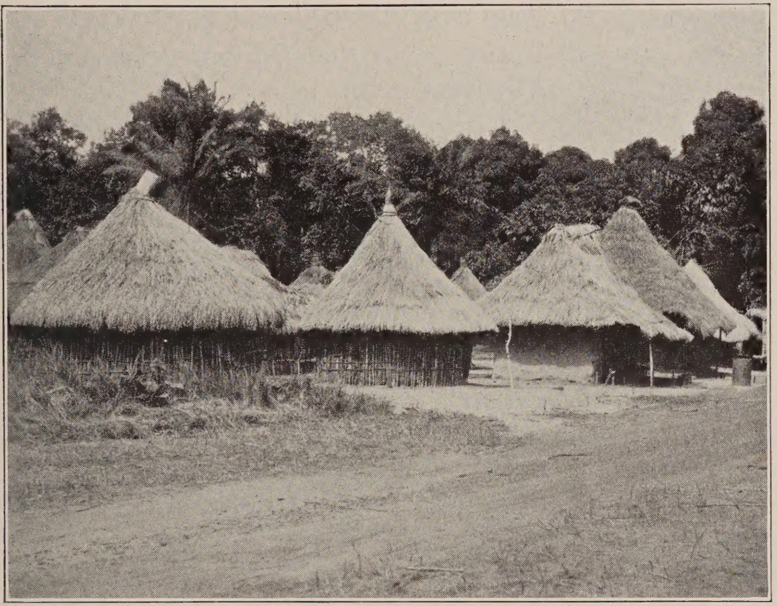
Our porters were paid never less than a shilling a man per day and we often fed them in addition. In some instances of prolonged marches they were paid two or two and a half shillings per man per day.

Owing to the difficulty of finding enough men to work as porters in some parts of the country, the Expedition frequently travelled in relays.

Base camps or stations were established at different villages in the interior, and field laboratories arranged. From these centers the surrounding country was explored in different directions by smaller groups whose expeditions would sometimes keep them away for several days.

The majority of the trails in Liberia are not especially difficult for travel on foot, and a number of them are as wide as roads. However, the trails lead through many low marshes or swamps, where there are a great many streams and some larger rivers that have to be crossed. There are rustic bridges crossing a few of the streams which are made often of the rattan palm and which are sometimes of the hammock type suspended by lianas. A bridge of this sort, somewhat unusual in structure, is shown in No. 440. However, there are no bridges across the great majority of the smaller streams that one has to cross every day. Many of them are crossed by monkey bridges, that is, the trunk of a slender tree, usually five or six inches wide, laid across the stream from bank to bank. When, as often happens, the streams are from twenty to forty feet wide, there is sometimes a series of such slender trunks laid across on which one must balance one's self with a pole more or less as if walking a tight rope. Occasionally a trunk of a giant tree several feet in diameter is laid across a stream. Almost every day more or less wading in water has to be done. One cannot travel in any direction in the interior without having to wade in water or through marshes. Liberia is unique in this respect. Sometimes one only wades up to one's ankles or knees, occasionally up to one's waist, and once in a while up to one's shoulders. In a few instances where narrow deep streams had to be crossed, it was necessary to climb up the trunks of trees for from thirty to forty feet, walk out on the overhanging branches, and drop from the slender tips to the bank on the other side of the stream. Although such a method of crossing streams is obviously not difficult for monkeys, or for natives accustomed to the practice, it is difficult for white people even in excellent physical condition. Moreover, a man with a fractured leg from a fall would have been difficult to transport in the forest where even carrying loads on the head is sometimes troublesome on account of the density of the bush.

The larger rivers on which there were no canoes were crossed on rafts made of the timber of trees hewn from the forest, tied together and interlaced with lianas. A rope made of lianas would be tied to a stout tree on a bank, and a



No. 98. — The road northward to the Junk River passing Congo Town

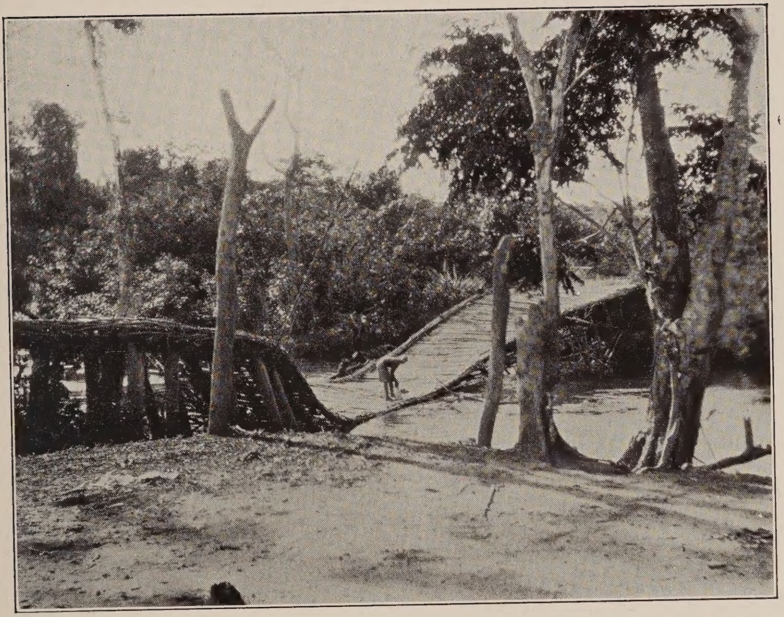
No. 99. — The trail northward from the Du River

man would then swim the river with this rope and tie the other end to a tree on the opposite side. The rafts would then be ferried back and forth with passengers and supplies. The swift currents usually made this method of ferrying particularly satisfactory, for it obviated both the need of poling or paddling and the danger of having rafts and supplies swept downstream.

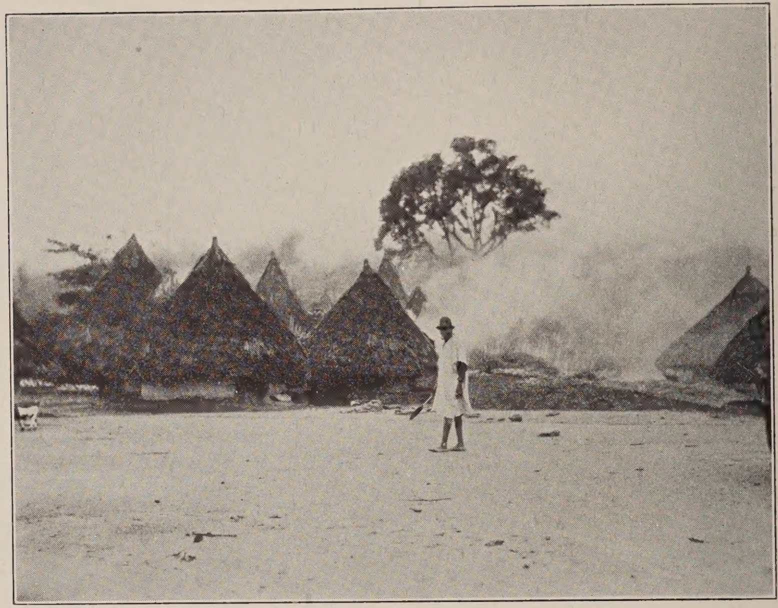
After a general idea of the conditions in the central regions of the country had been obtained, and an expedition made to the northeast at Garmu, on the border of French Guinea, in order that more territory might be covered, the Expedition was divided into two parties, the first of which, together with our collections, tentage, etc., returned to the coast and Monrovia through the country forming the western half of the basin of the St. Paul River, while the second proceeded to the eastern border of the country on the Ivory Coast, and then southward through the densely forested and little known part of Liberia to the sea. It was in this march southward that our greatest difficulties in travel were encountered. In various villages men were so scarce that some women had to be employed as porters. The people were wilder and more superstitious, and had had far less contact with civilization. Some of them apparently had not seen white men before. It was particularly in that part of the country which is marked on the published maps as the "Big Bush" that our greatest difficulty with porters arose.

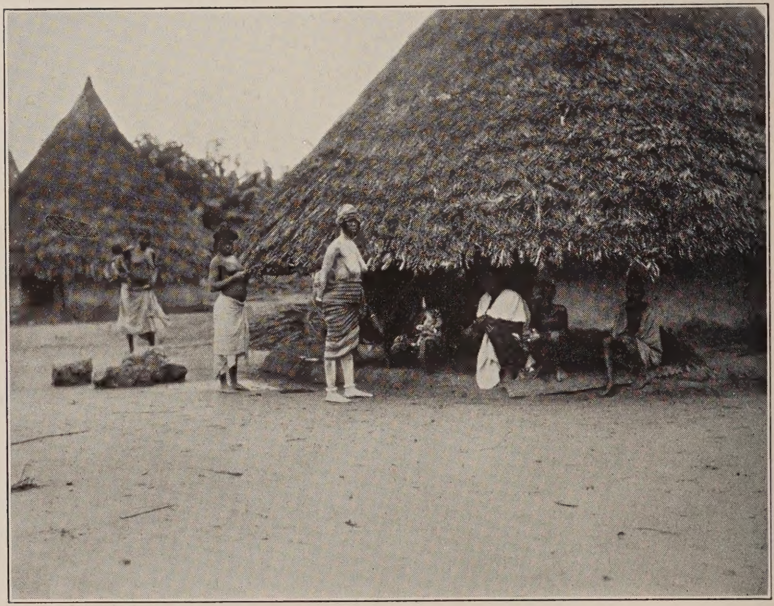
After we got into the dense virgin forest there were in places no regular trails, and at times we travelled chiefly by compass, but often followed the beds of dried-up streams, which of course never run straight for any distance. Progress through this forest was especially difficult on account of its density. In many places the slender trunks of the trees were so close together that there was barely enough room for a man's body to pass between them. This condition of affairs coupled with the fact that here and there the overhanging branches, lianas, and other forest growth were unusually low, especially impeded the progress of the porters with loads on their heads or swung on poles. In such regions the frequent use of the machete was required in cutting a passage.

Another obstacle to travel was that the ground was covered with a veritable network of radiating and interlacing surface roots which no doubt the heavy rains had exposed. Most of these surface roots are only a few inches high, but many are higher and form barriers or buttresses several feet tall and from ten to fifteen feet in width. One is particularly struck with the fact that the roots of the trees spread out rather than grow down, a phenomenon due in part to the hard granite rock which is found at a depth of usually not greater and often less than six or seven feet below the leaf mold of the forest. One result is that a great many of the giant trees of the forest, besides those that had died, had fallen, probably during hurricanes and strong winds. Some of them had trunks four or five feet in diameter, which when found lying across one's path, had of course either to be climbed over or walked round. All these things, trivial as they may seem, always delay considerably a long column of travel, because before every serious obstacle the load usually has to be put down and again placed on the head of the porter after the obstacle is passed.

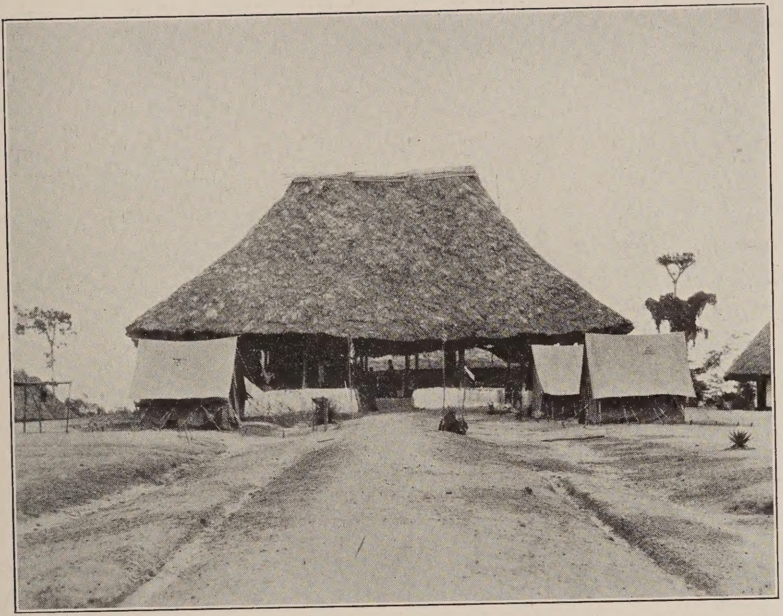


Nos. 100, 101. — Superior forms of native bridges

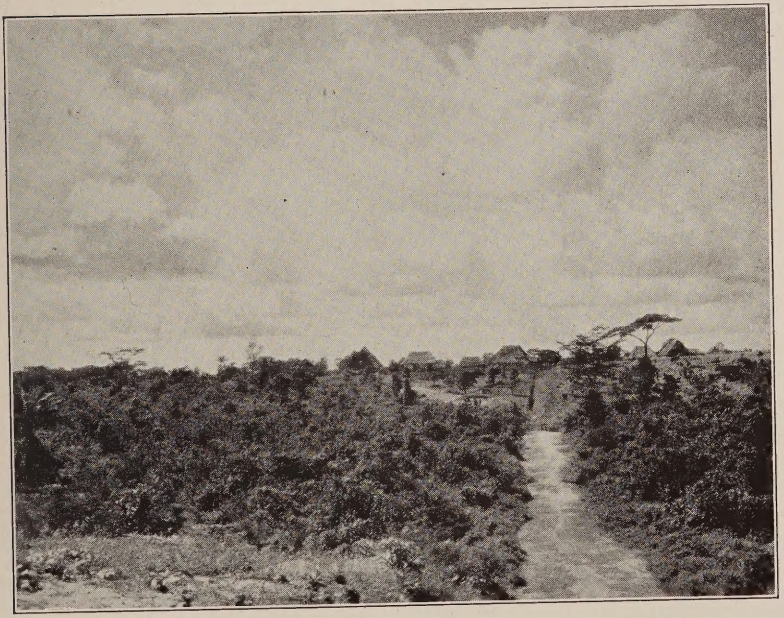




Nos. 102, 103. — Village of Garmu on the border of French Guinea



No. 104. — Base camp at Gbanga with laboratory building in the center

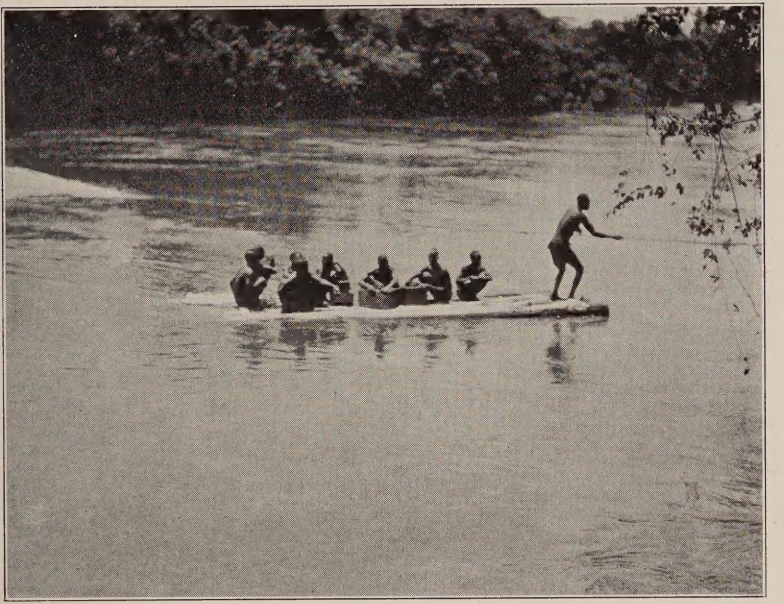


No. 105. — Trail leading northward from Gbanga

In this part of the country, we had also to cross a great many narrow, deep-running streams, particularly when we were travelling parallel with and near the river Cess, into which the many cross-streams flow with considerable swiftness near their mouths.

On account of the many obstacles the number of porters who deserted increased from day to day. Small bands of them would slip away from the trail into the surrounding forests where we would not be able to find and detain them. Many of them obviously became frightened at being away so long from their own villages in the forest. Others, we learned from our interpreters, thought that we were taking them down to the coast to make slaves of them. Most of them also believed that they would never receive anything for their services, and the carrying had become irksome to them. They had never been remunerated for work before. In a few instances in the eastern part of the country where we had paid porters at the close of the day, they seemed surprised at receiving silver and ran away promptly, perhaps fearing that we would later take the money from them. After many desertions by small groups, forty of our porters disappeared in one night. The following day we had to collect our supplies in the forest and select from them only the most necessary articles and abandon the rest. We finally crossed the river Cess and eventually reached the bank of the Sangwin River. Here we were able to persuade the Kulu people on the opposite banks that we were not hostile, but friendly. After considerable parley they sent emissaries across with two canoes and assisted us to cross and to travel to the village of Towya. There both rice and chickens were obtainable, and thence on to the coast at Sino only the usual difficulties of land travel in Liberia were encountered.

Among these ordinary difficulties of travel in Liberia is the management of the baggage train so that the porters do not become exhausted before the end of the day's march and unable to continue with valuable scientific specimens and collections, and with the tents, kitchen, and other equipment necessary for healthful camp life. In order to avoid the loss of valuable material, the column of march needs frequent supervision, a responsibility which can never be delegated to natives. Although theoretically it is inadvisable to travel in the tropics in the sun during the greatest heat of the day, with an expedition of the size and scope of ours, it was very often not practicable to avoid doing so. Although the actual breaking of camp, particularly when performed every day, can be carried out expeditiously, the summoning of porters before daybreak, and the inspection of their physical condition before the march, the division and arranging and tying of their loads upon their shoulders and heads, can never be done quickly, and usually consumes several hours. It is always especially difficult to collect porters before dawn. As many of the interior natives have no conception of discipline, the column of march may not start until eight or sometimes even nine o'clock in the morning. This obviously necessitates marching through the noon hours and usually until the later afternoon before making camp. When the sun is shining in the morning, as it usually is, the effect of its heat rays from ten o'clock onward made travel more



No. 106. — Crossing the St. John River on rafts

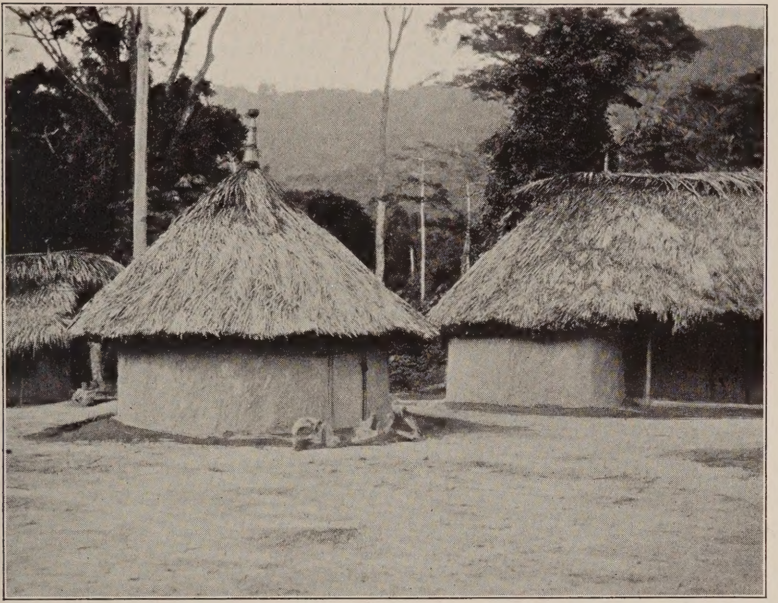
No. 107. — Crossing the Sangwin River in canoes

or less fatiguing, and from twelve to three or four o'clock the glare and heat are often so intense, that even the porters show evidences of suffering and often quickly jump into any swamps or streams that they may pass.

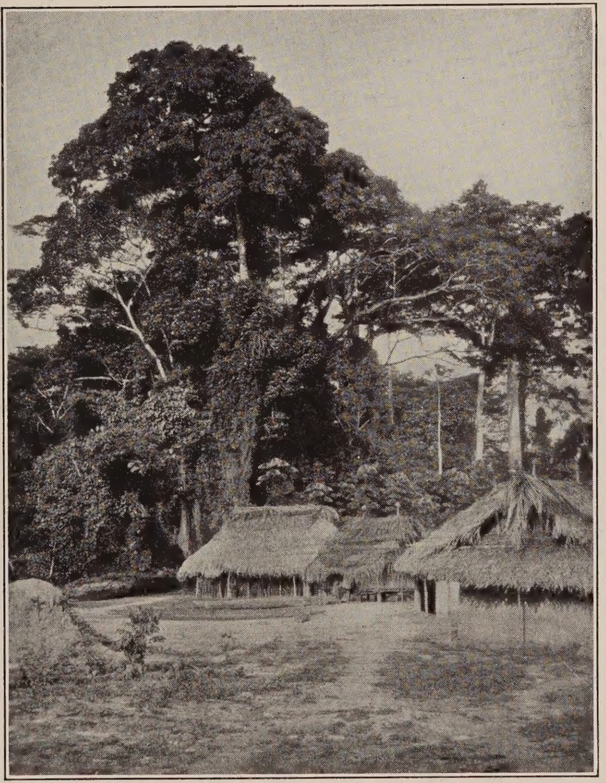
Relief from these hot and therefore sometimes very trying marches in the sun occasionally comes in the heavy tropical downpours, and when such showers do occur, one almost feels joy over the relief from the tropical sun's rays, and rejoices in being able to walk even for hours at a time in the drenching rain. Some days almost the entire march would be made in a pouring rain and on other occasions the showers were so frequent that for several days it was impossible for us to dry our wet clothing.

No. 108. — Arrival at the village of Granh

At Sino on the Atlantic Coast we were unable to attract the attention of any passing steamer. It was possible, however, to charter at that place a surfboat with a crew of eight native oarsmen in which we travelled up the coast, eventually reaching Monrovia. The boat had a sail but as it had no keel we could sail only when there was a fair wind. When the wind was adverse, or there was a calm, the oarsmen seldom seemed to have enough energy to row more than half an hour at a time. Navigation was somewhat difficult as the surf off the coast is high and the coast itself very rocky. Navigation was additionally difficult at night, because there were no lights. We could sometimes detect the reefs in the distance at night by the phosphorescence in the water as the waves broke over them; in other instances by the sound of the surf. The boat was an open one and the sea sufficiently high so that it continually tossed. The heavy tropical night showers, which sometimes lasted for several hours, not only soaked through clothing but also necessitated frequent bailing.



No. 109. — Trué Town, on the edge of great forest and River Cess



No 110. — Another view of Trué Town

Nos. 111, 112. — End of column of safari approaching Sordya

Nos. 113, 114. — Showing density of Bassa Forest at point where we emerged and crossed river to Towya Town

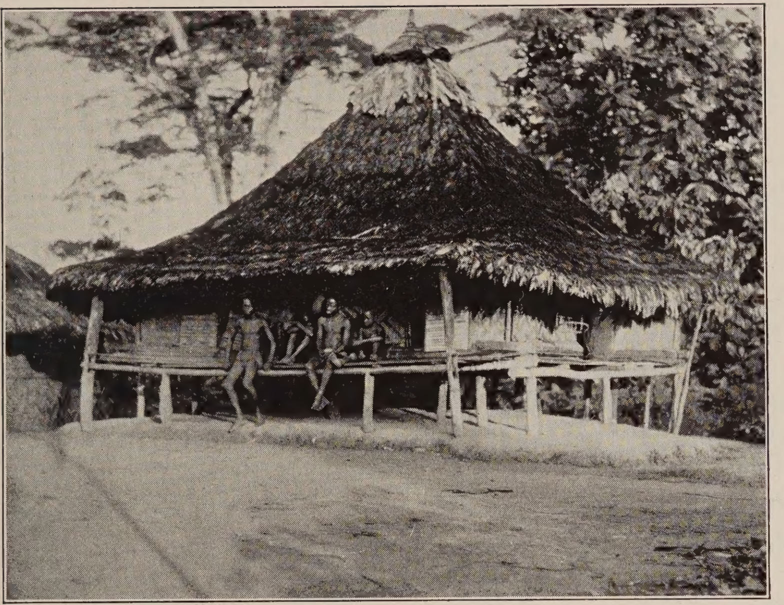
A stop was made at Grand Bassa near the mouth of the St. John River where fresh water was obtained, and the voyage then continued up the coast to Monrovia and thence by launch to Cape Mount.

Care of Personnel. Apropos of travelling through parts of the virgin forest of Liberia today, it is interesting to recall some of Livingstone's and Stanley's experiences in early African travel. Livingstone, after a number of prolonged illnesses, finally died of dysentery in eastern central Africa, — the same disease which killed our celebrated naturalist, Carl Akeley, in Africa two years ago. Precautions against infectious disease in many tropical regions are still continually necessary. Stanley, after having been unconscious and near unto death from fever on several occasions, said that he did not believe that, in respect to disease, parts of tropical Africa could ever be made safe for white men to travel through. On some of his expeditions he lost one-third of his personnel. In Stanley's time, however, we did not have the knowledge which the scientific study of tropical diseases has brought to us in respect to the prevention and cure of many infections, and to hygiene and camp sanitation. The conditions in some of the forests of Liberia, and in some of those of other parts of central Africa that we travelled through, are virtually unchanged since the time when Stanley travelled through them. Our Expedition of eight Americans, which spent almost a year in tropical Africa, has demonstrated that in almost any part of tropical Africa white men can travel and not succumb to disease, provided that they take the necessary hygienic precautions.

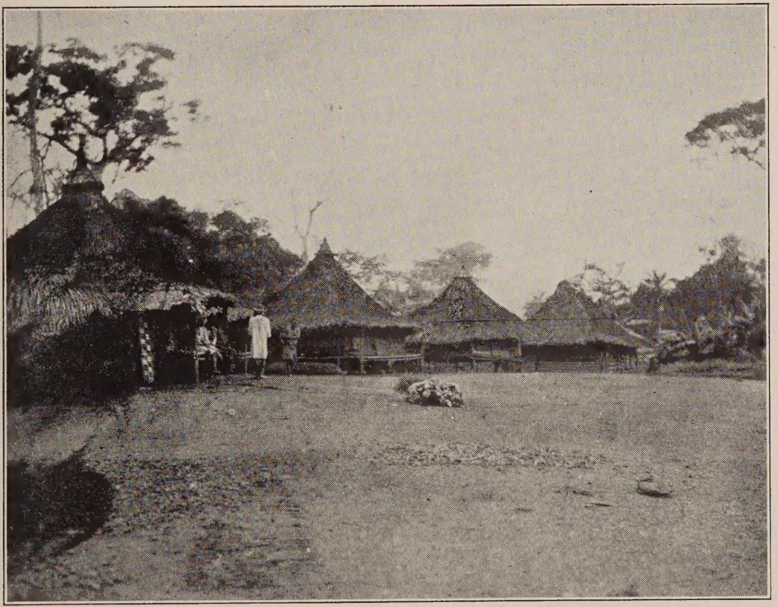
Much thought and continual care, however, are required in exercising the proper precautions. Matters of especial responsibility are the sterilization of drinking water and in some districts the investigation of the condition of the water used for bathing; the food supply and its cooking; the selection of camp sites with reference to sanitation and the occurrence of blood-sucking Diptera, the precautions to be taken against certain of these biting insects, and finally the prophylactic use of quinine.

The physical and mental condition of each member of the Expedition must be carefully and continually supervised. The men must be kept at work and interested. On long expeditions idleness almost invariably leads to discontent and trouble. The use and abuse of alcoholic drinks must be considered. In many isolated districts in the tropics where there is very little diversion, interest and enthusiasm must be aroused and maintained in the success of the Expedition, and each man made to feel how important his share in it is. In connection with these and other problems discipline is essential and must be maintained, if necessary even through the loss of some popularity.

Daily exercise through walking is advisable except in the case of illness or disability. The men must be informed and frequently advised and reminded of the risks of infection in the community, the nature of those risks, and the precautions to be taken in avoiding them. The care of the feet is obviously of very considerable importance where walking is the only means of transportation. The dangers of infection from going about camp or elsewhere in bare feet must be emphasized as well as the importance of wearing leggings and boots on the



No. 115. — Chief's residence, Towya Town



No. 116. — Bashman Town

trail or in the forest. The risk of sleeping in or inhabiting even for a few hours resthouses in some districts which have been occupied by the natives must be pointed out, and also the precautions to be taken when they must be occupied. Every case of illness must be carefully examined and treated. In cases of fever the blood must be carefully examined and proper and complete treatment carried out. Every case of diarrhoea must be investigated microscopically and promptly treated according to the diagnosis. The porters must be quartered and separated from the camp of the white people, and protected from rain at night, and arrangements must be made for their food and fire wood. Every case of disease among them must be investigated and treated. Only healthy men in good physical condition must be allowed to undertake the march.

Owing largely, no doubt, to the intelligent cooperation of my seven colleagues in the exercise of these and other hygienic precautions, there was not a case of dysentery or diarrhoea or of serious illness among them. Attacks of fever, never requiring the patient to be in bed for more than several days at a time, were the only illnesses experienced by any of us, and all came out of Africa in good physical condition.

Although in the light of certain recent experimental work upon malarial infection that bears on the prophylactic use of quinine, it seems that drug may not sometimes actually prevent primary infection with sporozoites of malaria, the great value in the use of quinine as a practical prophylactic to prevent serious malarial paroxysms and invalidism in men on expeditions in infected localities is, in the author's opinion, unquestionable. Fifteen grains of quinine taken on two successive days of the week (our custom on this Expedition) will not always prevent primary malarial infection, but when infection does result, the paroxysms are usually mild. Apparently the only disadvantage of moment in such prophylactic use of quinine is that it makes diagnosis difficult, for it is almost impossible to find malarial parasites in the blood of a man who is taking thirty grains of the drug a week. On the Expedition any case that was diagnosed as malaria as well as the cases in which parasites were actually found in the blood, was treated with from thirty to forty-five grains of quinine during four or five days, and then with fifteen grains daily for from six to eight weeks. In one instance a relapse with malarial paroxysms and parasites in the blood of the tertian variety occurred in one of the members of the Expedition a year and a half after his return to this country. The probable explanation is that, owing to the unpleasant effects of the quinine, it was difficult to persuade the patient after his return to the United States to pursue a six weeks' course of continued treatment with the drug.

In respect to the prophylactic use of quinine, the investigations of James, Nicol and Shute[1] are of interest. After having demonstrated that the injection into man of sporozoites obtained from infected mosquitoes produced infection, they performed the following experiment: two mosquitoes infected with *Plasmodium vivax* were placed in a 1-5000 solution of quinine bisulphate

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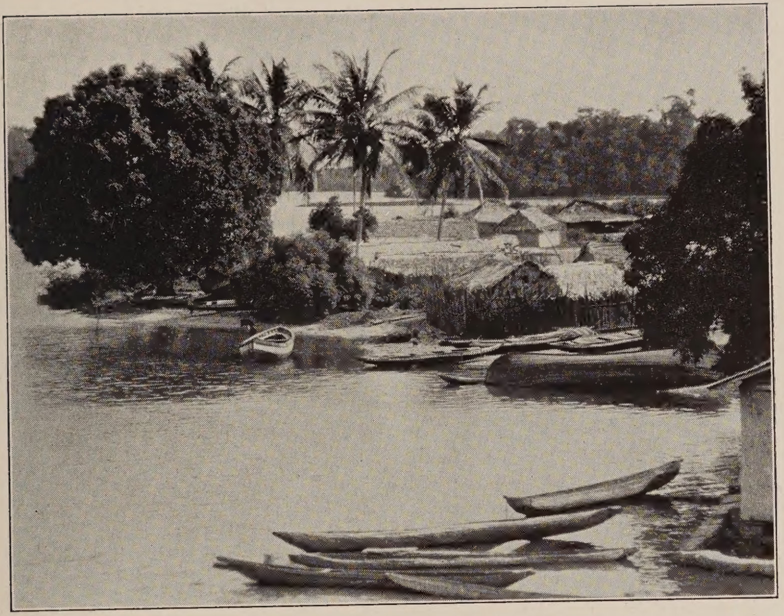
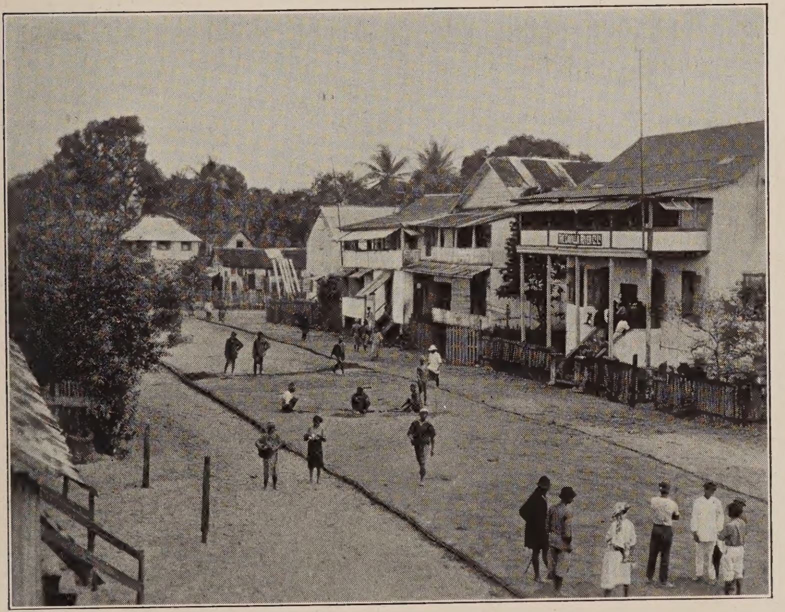
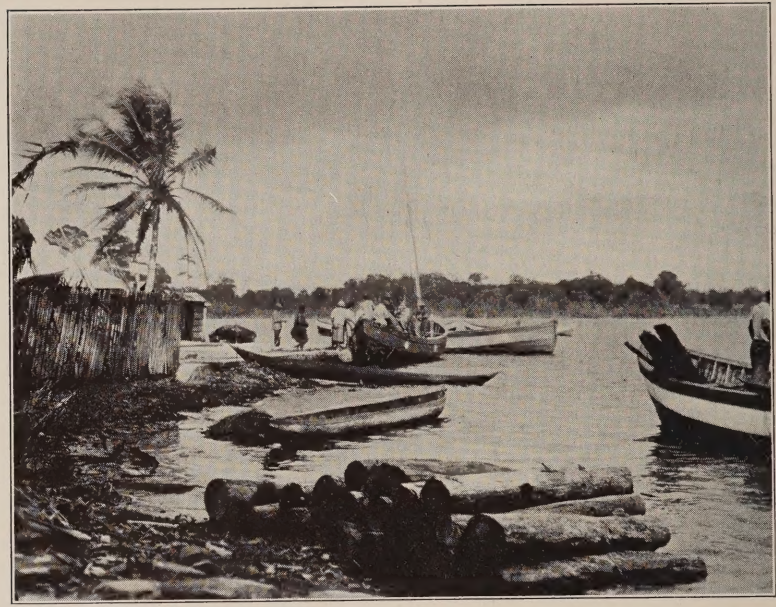
[1] James, Nicol and Shute: Trans. Royal Soc. Trop. Med. and Hyg. (1927), XXI, 233.



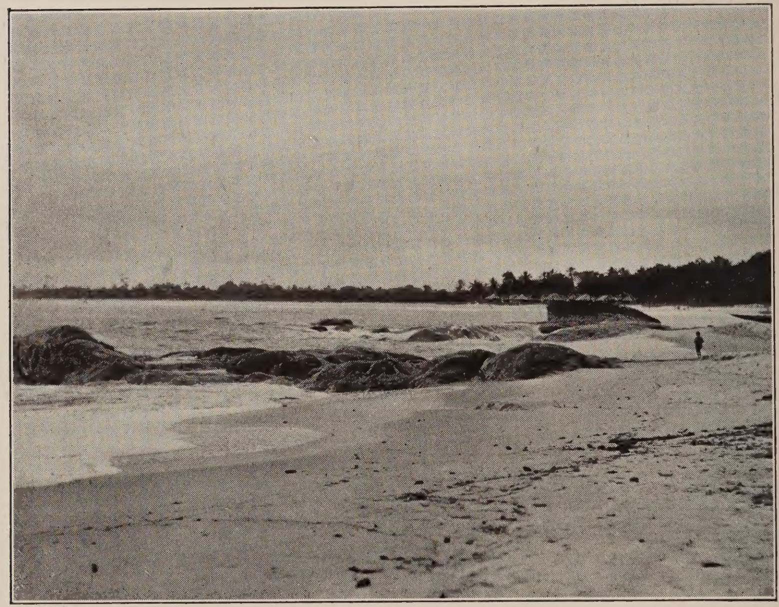
No. 117. — Ashanti village near Sino



No. 118. — Sino, principal street, showing fishing net being dried

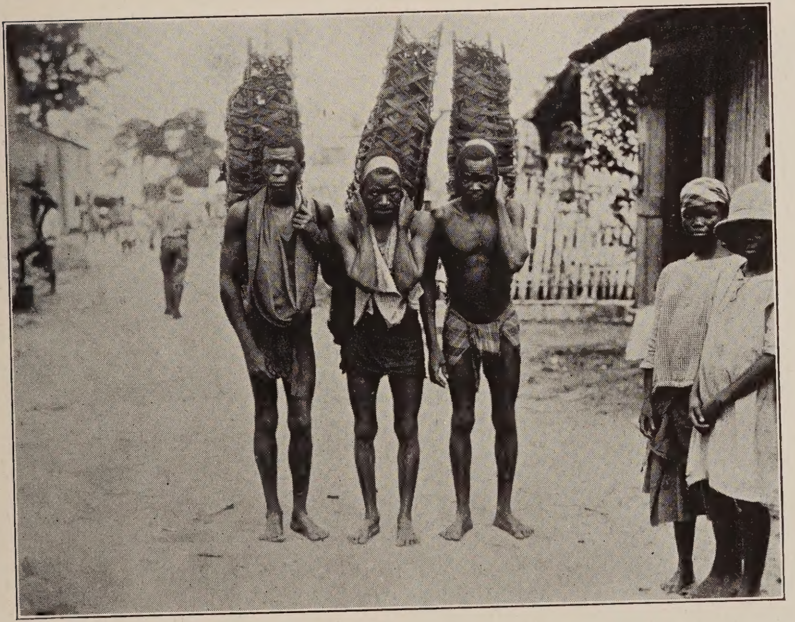


No. 119. — Boat on which we journeyed up the Liberian coast



No. 120. — Rocky coast north of Sino

No. 121. — Grand Bassa



No. 122. — Bassa porters

made up with human blood serum and their salivary glands dissected and teased up in the solution. One cubic centimeter of this solution containing many sporozoites was then drawn into a hypodermic syringe, allowed to remain for fifteen minutes and then injected intravenously into a patient. On the tenth day following inoculation the patient had a malarial paroxysm, the temperature rising to 103.6° F., and *Plasmodium vivax* was found in the blood. This experiment suggests that the sporozoites of *Plasmodium vivax* when exposed for fifteen minutes to a concentration of quinine equal to fifteen grains in the human being are not injured so far as infectivity is concerned, and that this dosage in prophylaxis is not sufficient to prevent infection. Several investigators have shown that infection with malaria sometimes occurs, even though the victim is taking as much as fifteen grains of quinine a day for prophylaxis. Yorke and Macfie [1] in their work upon the treatment of general paresis of the insane by malarial inoculations, have shown that eighteen grains of quinine daily for five days before and seven days after mosquito bites by infected *Anopheles* failed to avert an attack, but that when the drug was continued for ten days after the insect bite, the disease did not develop. These experiments, they believed, demonstrated that quinine had little or no effect on the infecting sporozoites, but only acted on the developed trophozoites in the red corpuscles of the blood. From their work it seems evident that quinine, taken before and for a few days only after being bitten by mosquitoes infected with malarial parasites, may fail to avert infection, but that if continued for ten days or longer after the insect bite, it prevents malarial attacks. Prolonged daily prophylactic quinine acts either by curing an attack of malaria at its onset by killing off the parasites after infection of the corpuscles has taken place, or by so reducing the degree of infection both in sporozoites and in trophozoites that an infection that otherwise would be severe becomes mild or comparatively harmless.

Craig [2] has recently reviewed the subject of the action of quinine on the malarial plasmodia. He concurs in the idea that, either directly or indirectly, quinine does destroy the malarial parasite in the blood of man. However, although he also believes that malarial infection cannot always be prevented, even though as much as one gram of quinine is taken daily for prophylaxis, he is emphatic in saying that this amount will prevent the appearance of symptoms so long as it is taken, and that therapeutic doses will cure the infection even before the development of symptoms. A most important piece of research in respect to quinine prophylaxis in the field has recently been carried out by McNabb and Stewart.[3] These medical officers made their observations on three companies of United States Army Engineers employed in mapping Panama. Quinine prophylaxis was compulsory; under strict supervision one gram of quinine was given each soldier daily in tablets or capsules before the evening meal. The men worked and were camped in intensely malarial places. The

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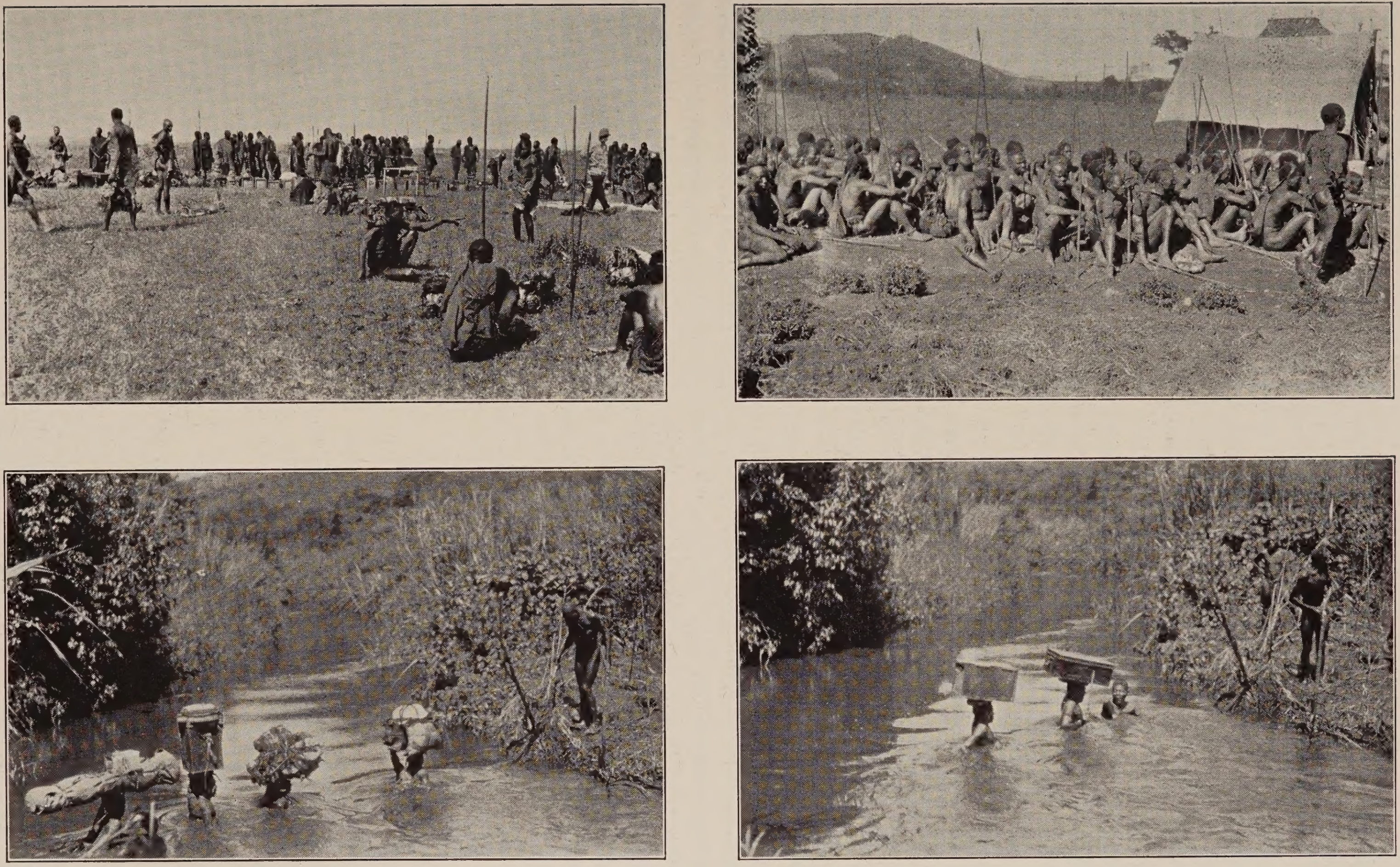
[1] Yorke and Macfie: Trans. Royal Soc. Med. and Hyg. (1924), XVIII, 13.

[2] Craig: Arch. Path. (1928), VI, 704.

[3] McNabb and Stewart: Amer. Jour. Trop. Med. (1927), VII, 357.



Nos. 123–126. — Safari and the route northward to Beni and the Semliki Valley in the Belgian Congo

investigators found that of the two hundred and twenty-five men who were engaged for four and a half months in mapping and who were taking one gram of quinine daily, only fourteen, or six per cent showed clinical symptoms of malaria. Only after the quinine was discontinued did the actual amount of infection in the command become manifest through the appearance of symptoms of malaria in one hundred and six persons, or forty-seven per cent. This work, although in conformity with Yorke and Macfie's conclusions that quinine does not prevent malarial infection, does not confirm their observation to the effect that continued use of the drug for from ten days to two weeks after exposure to the insect bite always prevents any subsequent malarial paroxysm. McNabb and Stewart conclude that under field conditions in a hot climate where men are undergoing physical hardship one gram of quinine will prevent the development of symptoms of malaria in men exposed to infection and will keep them on duty, and that although "quinine prophylaxis" will not prevent infection, it has great military value since it will enable troops to accomplish a mission in a malarious region. These observations also demonstrate that although quinine in the dosage given did not prevent malarial infection in forty-seven per cent of the persons concerned, the fact that over fifty per cent of them lived and worked for four and a half months in a most malarious region without developing symptoms of malaria even after discontinuing the quinine, indicates that even though infection may not have been prevented, a considerable number of persons must have been rid of the infection almost immediately after its occurrence. Craig believes that it is impossible that over fifty per cent of a command could escape the development of clinical malaria under such conditions had quinine not been administered. He also suggests that the effect of a larger prophylactic dose of quinine than one gram should be investigated, since he thinks it possible that a dose of 1.5 grams might be successful in freeing the vast majority of persons from infections that might occur before the appearance of symptoms.

XII

GEOLOGY AND FLORA

No careful geological investigations have been made in many parts of Liberia, but no minerals are known to occur there in sufficient quantities to be of such great commercial value as to justify their being worked. Yet, a government announcement was published in the Liberian News for April 1925, which read in part as follows: "The Republic of Liberia, the Garden of West Africa, 400 miles of Atlantic seacoast. It has the most fertile soil in West Africa. Its hinterland is covered with virgin forest. . . . Diamonds, gold, coal, iron, mica, and precious stones of every description have been discovered. Further information can be obtained from the chief Bureau of Information, Department of State, Liberia."

We saw evidences that prospectors had sought for minerals in a number of places in the interior, — plainly without success. A few years ago a small diamond deposit was found near the St. Paul River and a small gold mine near Careysberg, both not far from the coast. Although the mines were worked for a few years, nothing of great value was obtained from either of them and they have since been abandoned. However, granite, quartz, and mica are found in some parts of the interior and specimens of haematite have been obtained from central Liberia where, particularly in former years, the natives used to make use of this iron stone in the manufacture of knives, spear heads, hoes, and so forth.

The prevailing surface soil lying above the layers of granite or quartz consists for the most part of decomposed laterite, with more or less disintegrated organic material, and is interspersed with varying quantities of gravel and occasionally with small stones. Consequently, the soil in general is of a reddish or soft brown color, the redness of which varies according to the amount of the particles of oxidized iron which it contains. In other areas the soil is characterized by a layer of dark organic mold. This remark particularly applies to the soil around and among the hard brown laterite rocks seen near the coast. In still other regions, particularly on the banks of rivers, the soft black leaf mold prevails and constitutes a very rich nutritious soil. In other localities the laterite soil contains a variable proportion of clay or of sand which gives it a particularly sticky consistency when moist, and a lighter color. This soil, while not so rich as the leaf mold, gives rise to many herbaceous plants and is satisfactory for the cultivation of ordinary crops, particularly when it is mixed with the ashes of the natural vegetation.

Near the coast a friable sandy soil occurs which is also found in certain parts of the interior, where outcrops of sandstone are also sometimes seen.

Although small amounts of calcium are found in the laterite-containing soil, limestone itself has not been found in Liberia.

Chemical analyses of the soils have apparently not been made. Linder, however, points out that Martin has analyzed soil in Sierra Leone, that is predominantly laterite, and has found that its most important constituents are $Al_2O_3SiO_2$ and Fe_2O_3.

FLORA

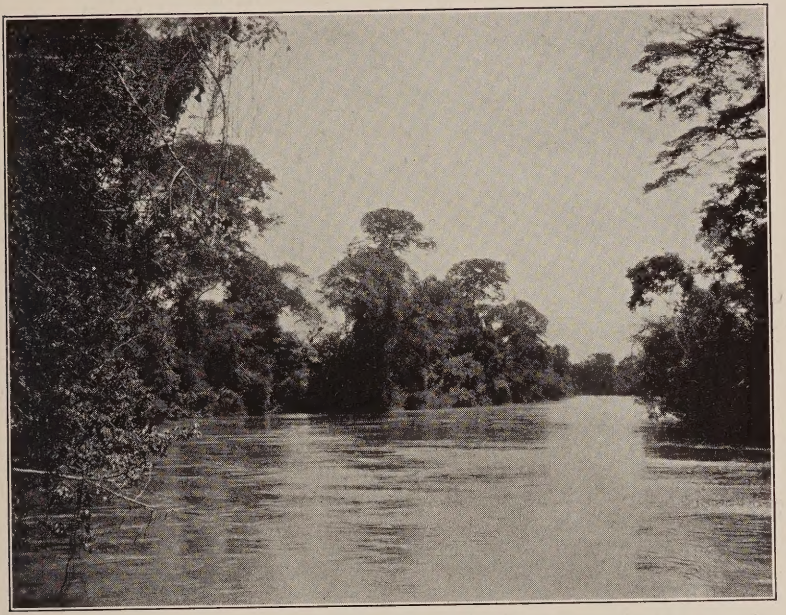
The tropical temperature, the heavy rainfall, the many rivers, streams and marshes, the uneven surface of Liberia, and the nature of the soil (its salinity and other mineral and organic constituents), influence the character and distribution of the floral types in Liberia more than the altitude. The flora in its entirety, although typically West African, has not only certain pecularities of its own, but other peculiarities analogous to those of the flora found in Sierra Leone and belonging to the botanical subregion styled by Johnston "Upper Guinea." By this term is understood a belt the maximum width of which is two hundred and fifty miles, of densely forested country along the West African coast, which begins to the south of the river Gambia and extends as far east as the country of Dahomey, and is characterized by a heavy rainfall. Through settlement and agriculture not only on the coast but in many parts of the interior, this primeval forest has given way and has been succeeded by a strikingly different flora. It particularly consists of dense scrub and secondary growth, with many low, shrubby trees. Owing to all these influences, one finds in Liberia a vegetation which varies considerably in the different regions specified. Thus, beginning near the coast may be seen either the growth especially associated with, and more or less characteristic of, the tropical mangrove swamp, or, especially along some of the tidal creeks or rivers, the grasses and vegetation of swampy meadows.

Travelling further inland and passing regions where herbaceous types especially prevail, one finds the lower forest of secondary growth, which is very characteristic, and which is interspersed in many large areas throughout the greater part of the country. In still other more marshy districts, where the raffia palm abounds, one finds characteristics of the swampy forest.

The primeval or virgin rain forest itself, especially characterized by its production of the largest trees, is found in areas distant from the villages, and in many instances separating territory occupied by different tribes.

Finally, in parts of the country to the north and eastward the vegetation is more like that of the savannas or park-like forest. The characteristics of the floral types in these different regions are particularly illustrated in Nos. 402 to 443, and are so fully described by Dr. Linder in Chapter XXXII, that no further reference will be made to them here.

Mention has already been made of the fact that many of the roots of the trees in the forest and in some other parts of the country are either near or on the surface. Others do not penetrate to more than a relatively slight depth into the deeper layers of the soil. Such a condition is brought about in part

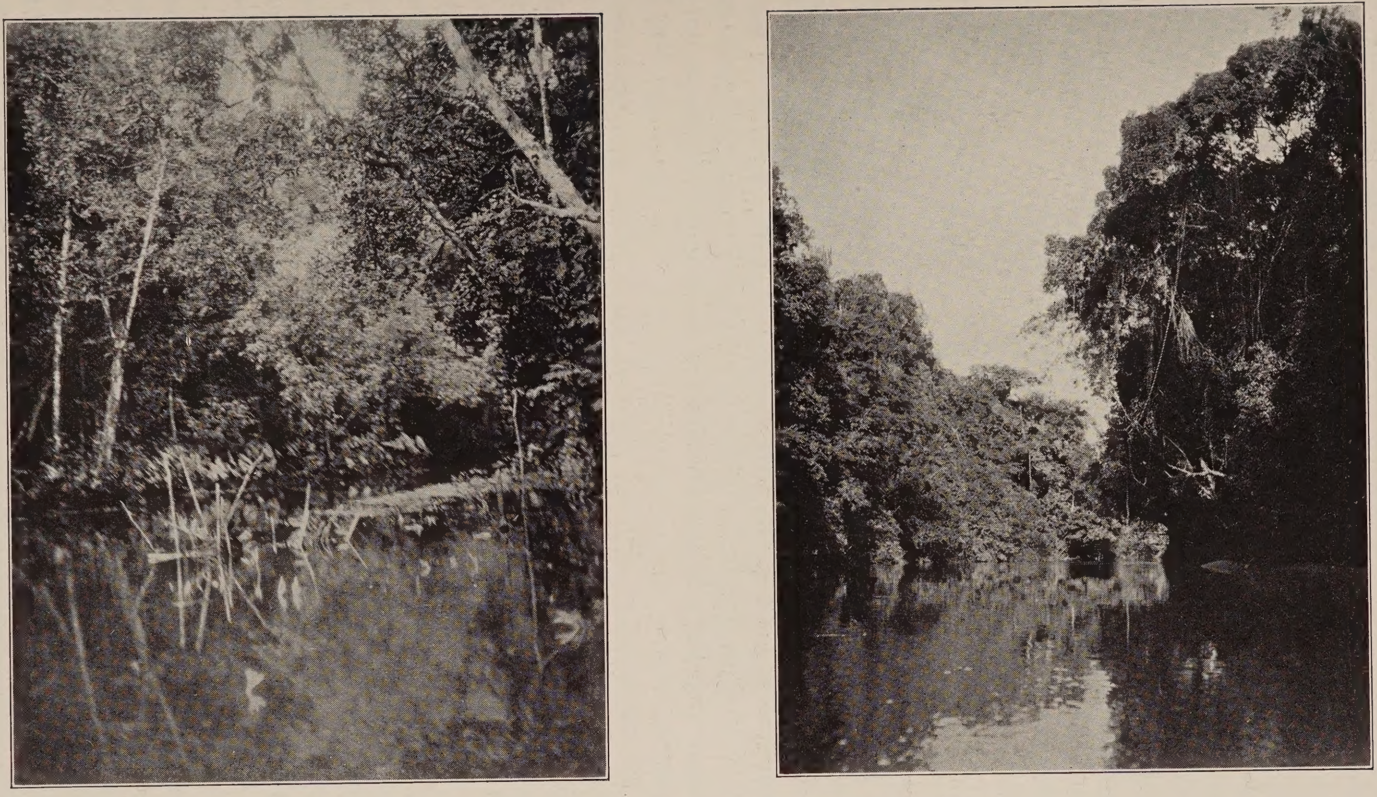


No. 127. — Characteristics of forest bordering Du River

No. 128. — *Ceiba pentandra* on the Du River

No. 129. — Soap tree, *Dracaena*

No. 130. — Plum tree, *Parinarium macrophyllum*



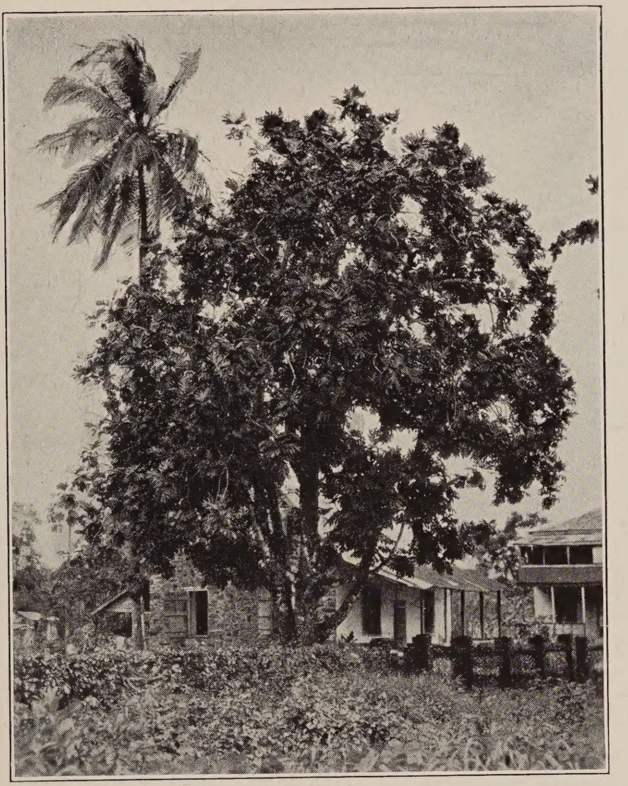
Nos. 131, 132. — Swampy forest, Junk River and Du River by the character of the soil and also by the exceedingly severe showers which tend to expose the roots. The traveller upon the trail is continually reminded of these surface roots and must raise his foot continually to step over them. The tendency of the roots of many of the trees to spread out rather than grow downward is also clearly the result of the geological structure of the deeper layers of the soil. As we have already pointed out, the soil of Liberia, which has such an important influence upon the character of the flora, shows in different parts of the country considerable variations in consistency and in its mineral and organic characters.

As might be expected, one finds affinities between the Liberian flora and the tropical southern and eastern Asian flora and even the South American. The distribution of *Maschalocephalus dinklagei,* named after its discoverer, Mr. Dinklage, which is the single representative of the South American Rapatacae found in Liberia, has been particularly studied by Dr. Linder (Map VII). This plant itself is illustrated in the photograph No. 437.

By travelling up the rivers of Liberia by canoe or launch, and occasionally making an excursion into the surrounding country, one can obtain a very interesting idea of many of the floral characteristics of the country. Nearer the coast the tidal streams are frequently lined with the mangrove, *Rhizophora racemosa,* and the other vegetation characteristic of the vicinity of mangrove swamps. One of the commonest of the floral plants along the banks of rivers is *Cyrtosperma,* with large leaves and flowers in spathes of a purple color with yellowish green streaks. As one ascends the river the *Pandanus candelabrum* (No. 135), or screw pine, with its gigantic aërial roots and spinous leaves becomes the most striking feature of the landscape.

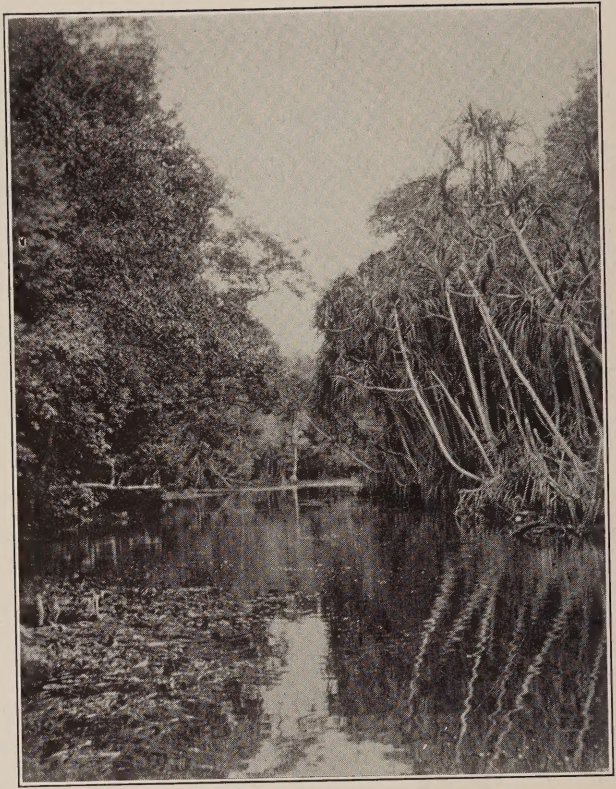
Still further inland the banks and adjacent marshy districts are covered with *Raphia vinifera* (No. 136), the piassava palm, so important commercially and in the domestic life of the natives. The larger oil palm, *Elaeis guineensis* (No. 138), of even greater commercial importance, prevails in great abundance in less marshy areas. Another striking palm frequently observed is the *Calamus* or rattan palm (No. 137), with its central fronds with whip-like stems, which grow out much like a long creeper, and which reach high above the surrounding vegetation or climb up the highest trees. The *Borassus* palm so abundant in many other parts of Africa, is conspicuous by its absence. It apparently does not occur in the interior, although its occurrence nearer the coast has been noted by Johnston and others.

In comparison with the flora observed along a number of South American tropical rivers the comparatively few species of palms observed in Liberia is a striking feature. In Liberia we know only some half-dozen species, whereas in the Amazon region, for example, the species of palms are in comparison exceedingly numerous. Indeed, besides the three just mentioned, only the coconut palm, *Cocos nucifera,* and wild date palm, *Phoenix reclinata* (No. 403), have been found in the country. The date palm which grows in low dense bushes, produces the sweet but coarse wild date, occasionally eaten by natives, but more commonly considered the food of elephants. The fibers from the midrib



No. 133. — Breadfruit tree, *Artocarpus incisa*

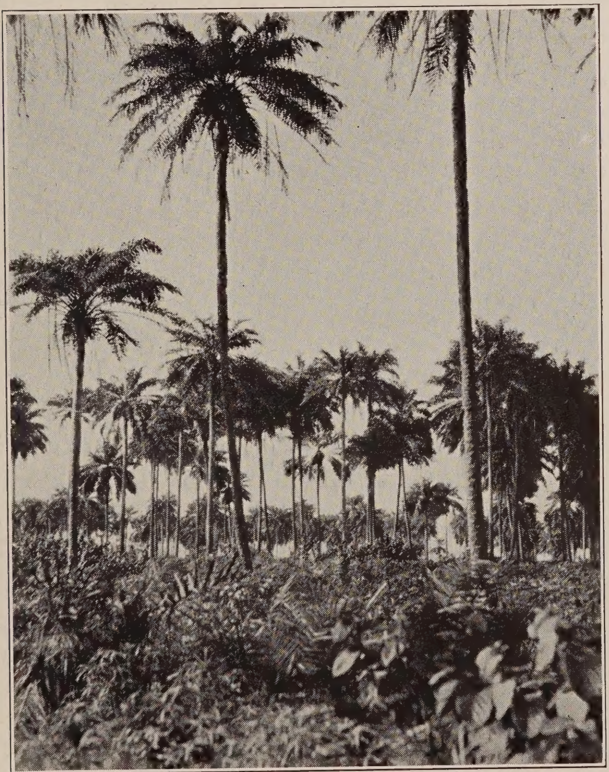
No. 134. — Coffee plantation



No. 135. — *Pandanus candelabrum*

No. 136. — *Raphia vinifera*, piassava palm

No. 137. — *Calamus*, rattan palm



No. 138. — *Elaeis guineensis*, oil palm

of this palm are frequently used as twine, as well as in weaving and in thatching. The coconut palm, which of course is not indigenous, and which probably was imported from the Pacific regions, is found only in a few places along the coast, and never in great abundance.

Another striking botanical difference between the flora along the South American rivers and those of Liberia is the absence of *Cecropia* trees. The myrmecophilous trumpet trees, particularly *Cecropia robusta* Huber, and *Cecropia palmata* Willd., with their bare white trunks often form groves in the secondary forests and clearings in parts of Brazil. In Liberia, one meets with a very striking plant or tree which is also especially characteristic of secondary forest, and rarely seen in virgin forest except near the borders. This is the *Musanga smithi*, a tree which is usually not more than from twenty to forty feet high. Maughan has described it under the name of the "umbrella tree," — a name suggested by the disposition of the leaves.

In Liberia, as in tropical South America, the *Ceiba pentandra* is one of the largest and most striking of the forest trees, and when in blossom, with its scarlet, bell-shaped flowers, it makes a beautiful and imposing appearance. Its trunk is sometimes used in Liberia for making dugouts. However, the silk cotton, or "kapok," that it produces is apparently not collected there or made use of commercially for stuffing sofa cushions as it is in parts of South America.

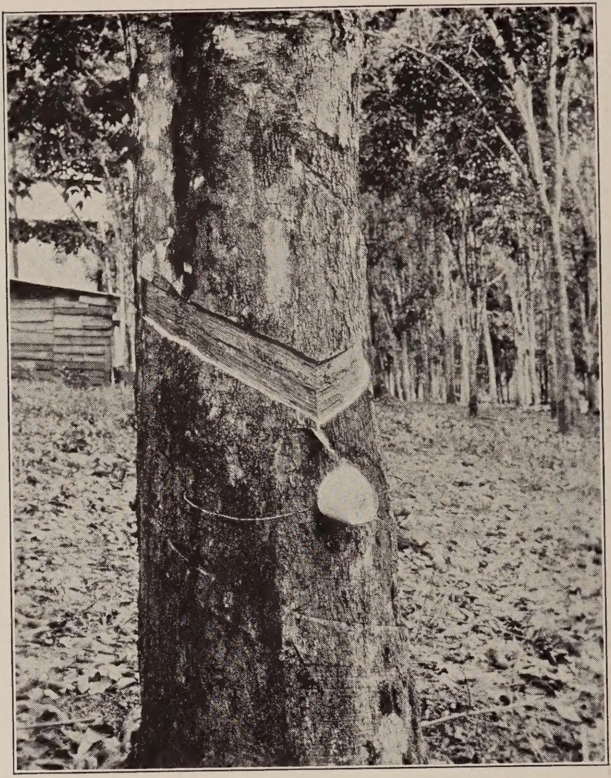
Among the most striking of the larger trees of the Liberian forest are *Dialium dinklagei* and *D. guineense*, with light, cream-white flowers. According to Dr. Linder, they reach a height of from one hundred and seventy-five to two hundred feet. *Brachystegia leonensis*, *Macrolobium macrophyllum*, and *Pterocarpus santalinoides* reach a height of approximately one hundred and twenty-five feet. Another of the larger and more abundant trees is *Xylopia africana*, which grows to a height of one hundred and fifty feet, and which apparently has a long, indeed an almost continuous, fruiting season (No. 417).

In the virgin forest there are also many leguminous trees and many species of *Ficus* of less, though of considerable size, besides numerous examples of Apocynaceae, among which the rubber-producing varieties are classified. One of the most important of the rubber-producing trees commercially, and the largest is *Funtumia elastica*. Johnston says that this tree is one of the tallest in the African forest, and intimates that in Liberia it may grow to two hundred feet in height. We, however, did not observe trees of this species of such great size.

Among other particularly striking trees in Liberia is the *Dracaena* of the order Liliaceae. It has glossy dark green leaves, white aloe-like flowers, and bright red berries. Some grow to a good size. They are prominent not only in the forest but around the villages and towns, where on account of their striking appearance they are planted to mark boundaries. In some places they are set out for stockades and hedges. The natives sometimes call them the "soap tree" (No. 129).

Bamboo is found in small thickets near the coast and also for some thirty or forty miles inland along some of the rivers. It is apparently not indigenous, but was imported earlier from the West Indies. It is well known that *Oxytenan-*

Nos. 139, 140. — Character of forest in region of rubber plantations near our camp



No. 141. — Rubber tree, *Hevea brasiliensis*, showing method of tapping

No. 142. — Liberian banana in the interior at Sessu

No. 143. — *Gloriosa superba*, the poison plant

No. 144. — Vanilla flower, *Vanilla africana*

thera, the bamboo indigenous to other parts of tropical Africa, is found only on high hills or mountains, not lower than 3000 feet above sea level, and in many places not lower than 6000 to 7000 feet.

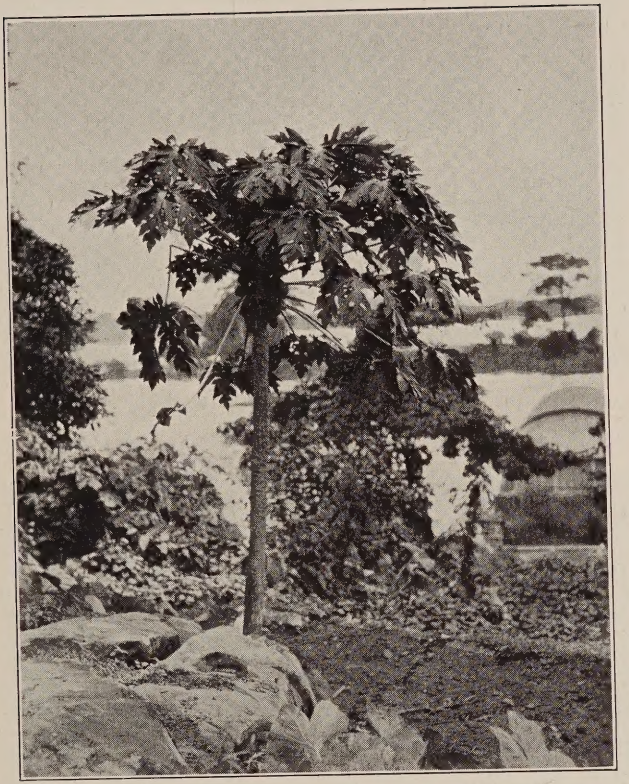
The interior of Liberia is exceedingly rich in ferns, and in certain regions bracken is particularly plentiful.

Perhaps the most striking flowering plant, and one which the traveller instinctively stops to pick and examine, is the *Mussaenda conopharyngifolia.* The commonest Liberian species has clusters of tubular orange flowers. In connection with the tubular flower a single white sepal is developed at the base of the corolla which resembles a specially developed leaf. These exaggerated sepals are smooth, pure white in color, and have a velvety surface. On account of its very striking appearance and its prevalence in Liberia, Johnston selected it as the national flower of the country. In parts of the eastern Congo particularly in the Ituri Forest, we found a *Mussaenda* with beautiful crimson sepals in place of white, which until one closely examined the plant, resembles poinsettia.

References have already been made in Chapter IX to the floral types of Liberia of special value from an agricultural, commercial, and pharmacological standpoint, and to the different uses to which these plants are employed by the natives. Some of these are also illustrated in this chapter.

The most complete enumeration of the Liberian flora which we have had until now, was made by Otto Stapf and published by Johnston in 1906. The list was made largely from the material in the herbarium of the Royal Botanic Gardens, Kew, and was based in general on material collected by various botanists in the coastal region. Among the most important of the collections are those of Mr. Max Dinklage, who at the time of our visit, was still living in Monrovia and acting as German Consul, and who gave us much valuable assistance and advice in connection with botanical work; and of Mr. Alexander Whyte, late Superintendent of the Botanic Garden at Entebbe, Uganda, who collected chiefly within a radius of twenty miles around Kaka Town, but who also collected on the coast.

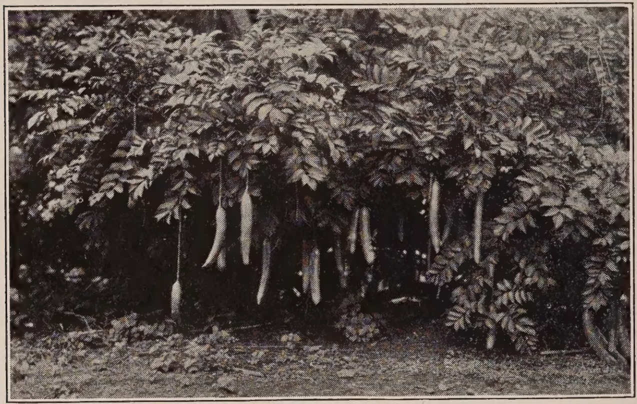
The collection made in Liberia by Dr. Linder, the botanist of the Expedition, and by Dr. Bequaert, which has been analyzed as far as has been practicable by Dr. Linder since his return from Liberia, consists of 1601 specimens. Among these, 1012 are of shrubs, bushes or herbs; 182 of trees; 43 of orchids; and the remainder of ferns, mosses, algae, and fungi. While many of the species have already been determined and are referred to by Dr. Linder in his botanical account of the work of the Expedition (Chapter XXXII), only an incomplete picture can as yet be given of the flora of Liberia, since the species in the large families of Rubiaceae, Apocynaceae, Marantaceae, Zingiberaceae, Commelinaceae, and others are still undetermined. We have been fortunate, however, in having the assistance of Mr. Hill and his associates at Kew, in determining the species of part of the flowering plants that were collected, and of Dr. Oakes Ames in determining the species of a part of the orchids. To both gentlemen grateful acknowledgment is here made.



No. 145. — Pawpaw tree, *Carica papaya*

No. 146. — Almond tree, *Terminalia catappa*

No. 147. — Bamboo grove, Du River



No. 148. — Sausage tree, Bignoniaceae, probably *Kigelia*

No. 149. — *Theobroma cacao* at Towya

XIII

ZOOLOGY

The fauna of Liberia has been studied in early years by Büttikofer and his assistants, and their descriptions, which were collected and published in 1890, and those made and compiled by Johnston in 1906, have laid the foundation for our zoological knowledge of the country. However, neither Büttikofer nor Johnston travelled very far into the interior; indeed their observations were mostly confined to the region not more than thirty miles from the coast. Therefore, it was important and desirable that observations should be made further inland in the central parts of the country, in order to compare them with those already made on the coast or in the coastal region. Such inland studies were made upon the present expedition.

Johnston remarks of the coastal region that what strikes the traveller most in respect to the fauna of Liberia is its absence. He says that in no part of Africa that he has visited has there seemed at first sight a more striking lack of animal life.

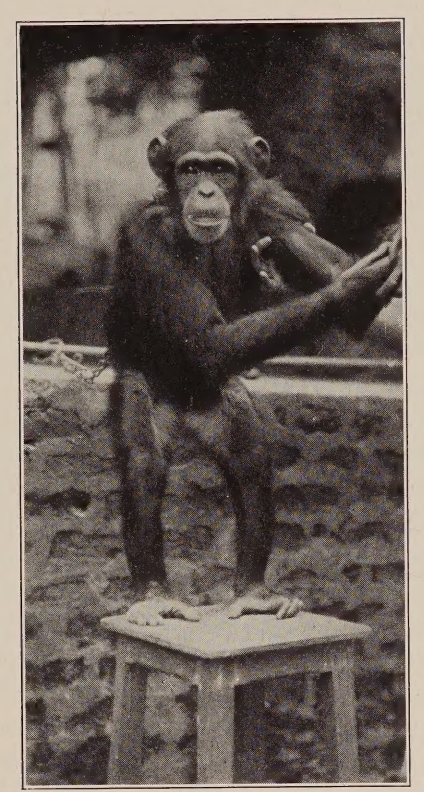
This impression one retains to a considerable extent when one travels in the interior of the country, where, with the exception of a few birds about the plantations, there appears to be a marked absence of wild life in general and of big game in particular. History tells us that in the earlier years the reverse was true at least of the coastal regions, and that, on the contrary, wild game — antelopes, buffaloes, and elephants — was plentiful. The absence during many years of any self-restraint on the part of the natives in the matter of hunting, together with the natural comparative paucity there of both domestic and wild animals of every sort, is probably responsible for the present conditions, for the interior tribes feeling frequently the scarcity or absence of meat, apparently killed for food every form of animal life they could lay their hands on, and only in exceptional instances attempted to raise cattle or sheep. The natural lack of certain wild game may also be due in part to the fact that the West African forest, which passes through Liberia is cut off by hundreds of miles from the next great forest region to the east, the country between Old Calabar, the Cameroons, and the Upper Congo. Moreover, the West African forest region is to a considerable extent isolated to the southeast from the Ashanti Forest by the grassy plains of the Ivory Coast, and to the west and northwest is partly separated from the forests of Portuguese and French Guinea by the highlands of Futajalon. It may be that from these and other deforested areas the larger part of the wild game in earlier years travelled eastward rather than westward. Whatever the reason, one finds today nowhere in the interior of Liberia any abundance of wild game; there are no plains or open fields upon which antelopes or buffaloes graze in herds, and the few wild animals that exist are found for the most part in the forest.

Among the mammals the chimpanzees, monkeys, lemurs, squirrels, shrews, and duikers are the most common. Of the monkeys there are four species of *Cercopithecus*, three of *Colobus*, and one of *Cercocebus*. These monkeys are of special interest on account of the infections with malarial and other parasites that were found among them,a fact that will be discussed later in this Report.

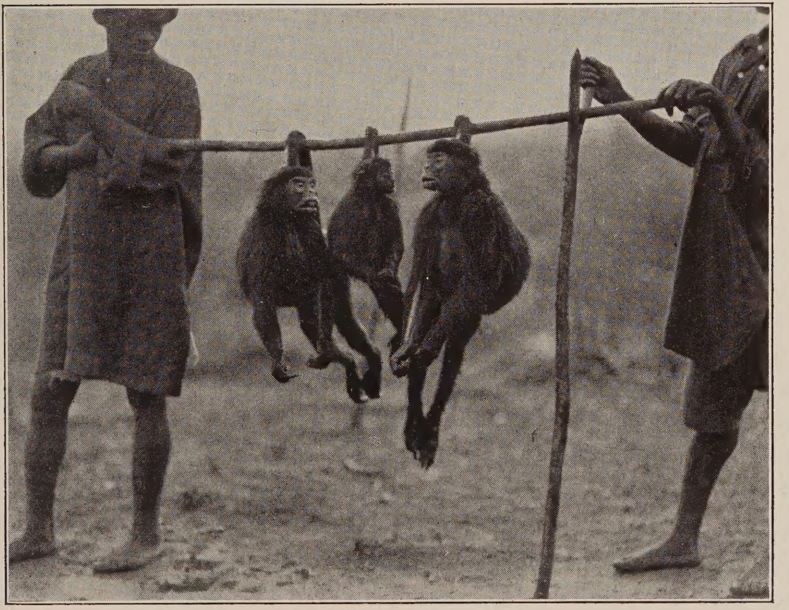
Many of the natives in Liberia speak at times of the baboon, the name by which they refer to the chimpanzee. The true baboon apparently does not occur in the country. Among the lemurs of Liberia, which are distinguished especially from the true monkeys by the incisiform character of the lower canine teeth and which live largely on insects, are *Perodictius potto* and *Galagoides demidoffi*. Both the *potto* and the *galagos* sleep throughout the day and are active at night. The *potto* in particular utters loud startling sounds in the forest during the night hours, sounds which resemble those made by the hyrax (*Procavia dorsalis*), and which the natives sometimes associate with evil spirits. The awe in which many of them hold the *potto* is referred to in the zoological report of the mammals (Chapter XXXIII).

The carnivorous animals of Liberia consist of the leopard, serval cat, golden cat (*Felis aurata*), and civet cat, 2 genets and pardaline genet, three species of mongoose or *Ichneumon* and two of otter. In former years musk glands of the big civet cat provided, according to Johnston, an important article of Liberian commerce. Neither the lion nor the hyena have been definitely found in Liberia. The leopard is not uncommon; more leopard skins and parts of skins are seen in Liberia than those of any other animal. They are much dreaded for their ferocity, especially by the natives. The usual native practice is to catch them in pitfalls and then kill them.

The commonest antelopes in Liberia are the duikers, *Cephalophus*, of which there are at least seven species. They are all dwellers in the thickets or in the forest. The natives in the neighborhood of Gbanga hunt them by sending out beaters who advance toward a wall made of a series of nets some six feet high behind which other natives with bows and arrows are stationed. In other parts of the country they are captured either by being driven into ditches, or by foot or neck snares. More rarely they are shot from ambush from a tree or an ant hill, generally with a slug from an old Springfield rifle, but occasionally with a shot gun. Allen and Coolidge regard *Cephalophus maxwelli* as probably the commonest species of the genus in Liberia. They point out that these duikers are difficult to shoot on account of their nocturnal or crepuscular habits, and because they keep largely to the shelter of dense thickets in the forest. The smallest of the horned ruminants, the royal antelope, *Neotragus pygmaeus*, is illustrated in No. 153. It is only from nine to ten inches high, and about twenty inches long. Its limbs are long and slender, and the forefeet have no lateral hoofs. The body is usually golden brown, the forehead and nose ridge black, and the chin white. The smooth horns are about three-fourths of an inch in length. Johnston calls attention to the fact that this tiny *Neotragus*



No. 150. — Chimpanzee, *Pan satyrus*



No. 151. — *Colobus ferrugineus*

received the name of royal antelope in the eighteenth century from Pennant who was under the impression that it was the "king of harts" referred to by Bosman. Bosman, however, when he repeated native traditions about the animals of Guinea possibly used the name "king of harts" to refer to the water chevrotain, which in the folklore of West Africa is renowned for its extraordinary sagacity. The young specimen here illustrated was kept alive by Mr. Coolidge for two weeks by feeding it liquids through an eye dropper. The water chevrotain of the Tragulidae is of special interest from a zoological standpoint on account of its legs and feet, which are so constructed that it can walk on the edges or tips of its middle hoofs; in normal walking the side toes never touch the ground. It is very near the intermediate types of even-toed ungulates which connect the pig and camel groups with the Pecora (deer, giraffe, antelopes, oxen, and sheep). These and its other zoological features are also pointed out by Allen and Coolidge. The animal is a rich brown in color, and when full grown, about three feet long and two feet in height at the shoulder.

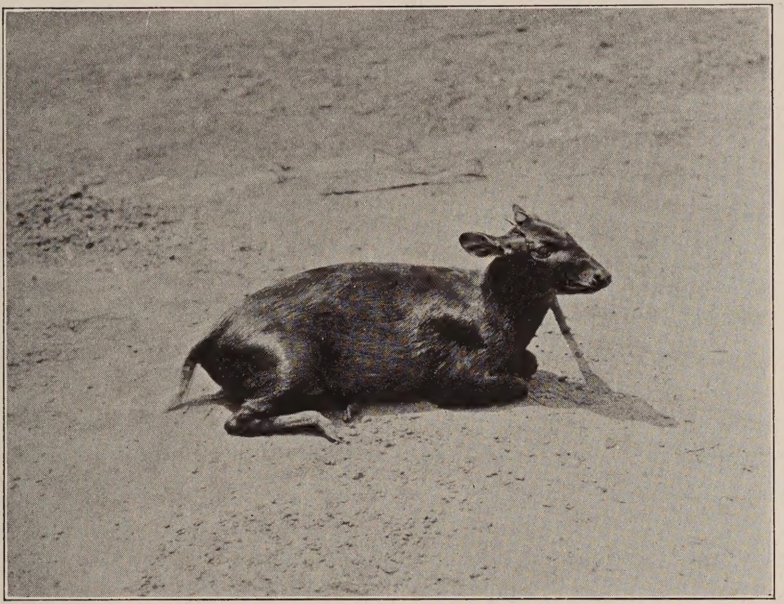
Two of the most striking mammals of Liberia are the tragelaphs. The *Tragelaphus scriptus*, or harnessed antelope, has a reddish golden or buff-colored coat, with white rectangular stripes and spots. The broad-horned tragelaph or bongo (*Boocercus euryceros*) is perhaps the most beautiful animal in Liberia. The coat is described as a splendid red-gold, boldly striped and marked with pure white; the face, throat, and limbs have bold white markings, particularly on the inner side which on the limbs is in marked contrast to the black color of their outer surface. The broad, boldly twisted horns are white at the tip. A young specimen of the harnessed antelope, brought to the writer alive in Kaka Town (No. 154), was later killed and the pelt turned over to the zoological collection. No parasites were found in this animal but in a specimen shot in the Belgian Congo an amphistome was found in the intestine (page 452).

The edentates are represented by three species of pangolins, or scaly ant-eaters, one of which, *Uromanis longicaudatus*, is illustrated in Nos. 156–157.

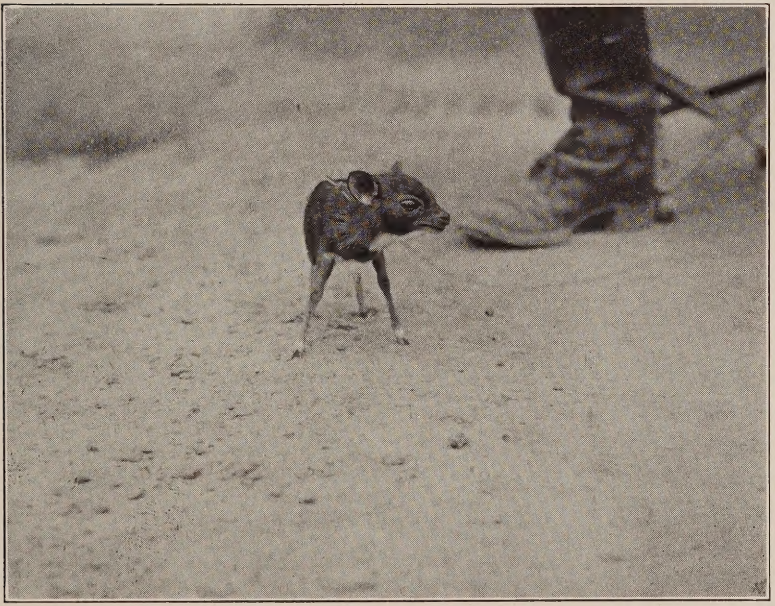
One of the most striking representatives of the Liberian fauna is the pygmy hippopotamus, *Choeropsis liberiensis*, of which representatives have been observed in the zoological museums at London and Paris. It is approximately one-third the size of the common East African hippopotamus, and has usually only one pair of incisors in the lower jaw. The proportions of the head are also different. So far it is actually found only in the forests and rivers of Liberia and the adjacent borders of Sierra Leone. These animals are rapidly disappearing and we were unable to find one in Liberia.

Neither the rhinoceros nor wart hog nor the gorilla of East Africa have been found in Liberia.

The red buffalo, *Bubalus nanus* or *Syncerus planiceros* (called by the natives the bush cow) is still found in Liberia in certain forest regions. The meat of this animal with the skin and hair still on, was in a few instances observed for sale in the market places in the interior. It is not, however, found in great abundance and is evidently fast disappearing. *Bubalus caffer*, the larger Cape type of buffalo apparently does not occur in Liberia. Allen describes the Libe-



No. 152. — Liberian duiker, *Cephalophus*



No. 153. — Royal antelope, *Neotragus pygmaeus*

rian species of bush cow as *Syncerus nanus* (page 614). Johnston[1] conjectured that *S. planiceros* was a smaller buffalo found in the open country of the Mandingo Plateau, whereas *Bubalus nanus* was found in the forest districts. However, he himself did not see either in Liberia. Although we did not observe the small red buffalo, it seems from the description given of the Liberian type in Büttikofer's specimens, that one of the Liberian species may be identical with the red buffalo of the eastern Congo, particularly with the pygmy red buffalo of the Ituri Forest, *Bubalus nanus*. In parts of the interior of Liberia the natives hunt the bush cow chiefly by trapping it in pitfalls or in spear traps, although occasionally they shoot it in the glades of the forest or on its borders. The red river pig, *Koiropotamus porcus*, is said to occur in Liberia, but appears to be rare and is seldom seen. No specimens of the forest pig (*Hylochoerus*) appear to have been observed in Liberia.

Elephants, although still present in certain parts of the country, are fast disappearing, and are already very scarce. When they appear they are usually successfully hunted by the natives even with their crude methods, and it does not seem likely that they will survive for a much longer period. The amount of ivory exported from Liberia is negligible. There has been much discussion of the existence of a pygmy elephant, but although there is no doubt that the Liberian elephants are small, no one has yet definitely found and described a pygmy species. Since leaving Liberia I received a cable saying that a pygmy elephant had been captured there, and offering it for sale. However, before it could be shipped to this country and carefully examined, word was received of its death. As the elephant was said to be a young one, it was presumed that its skull would probably not be of value as a museum specimen. Small elephants have often been reported as having been seen in Liberia, but a distinct pygmy elephant has not yet been found. However, the possible existence of a pygmy species is discussed on page 616 by Allen and Coolidge.

Allen and Coolidge list one hundred and one species in their study of the mammals of Liberia which is based on the specimens described and collected on the present Expedition. Among the smaller mammals are five species of shrews; nineteen of bats; two of otters or weasels; two of mongooses; eight of monkeys; two of lemurs; ten of squirrels; sixteen of rats and mice. Five species are recorded by them for the first time from the Liberian area. These are the rat *Hylomyscus alleni simus*, the shrew *Crocidura nigricans*, the bats *Petalia arge* and *Hipposideros langi* and the squirrel *Anomalurella pusillus*. *Hylomyscus alleni simus* is a new subspecies and is described on page 599. They found that the trapping of small animals was especially difficult. On account of heavy rains the bait soon became unattractive and moreover usually became quickly covered with ants. Even the specimens themselves when taken had in a number of instances been destroyed by these insects.

Ornithology. The study of the birds of Liberia was made by Dr. Glover M. Allen. In obtaining this Liberian collection, which covers a region hitherto neglected, he was especially assisted by Mr. Loring Whitman, who took a great

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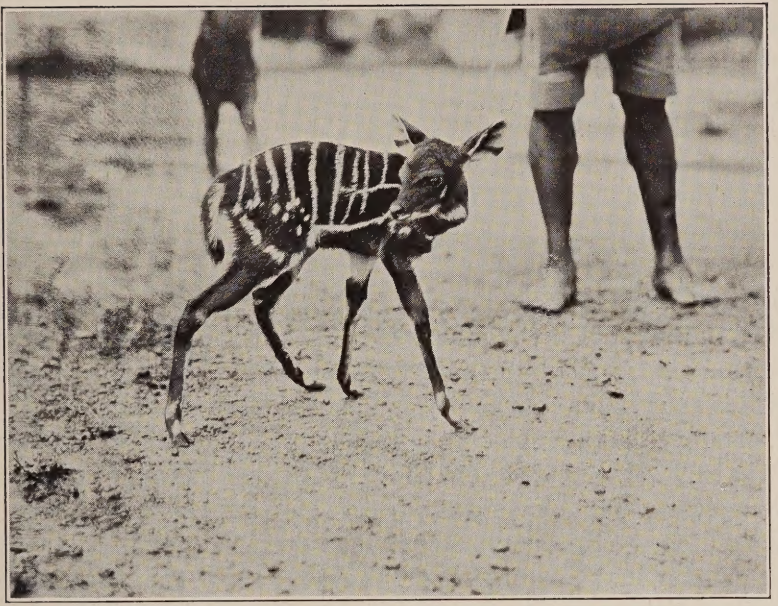
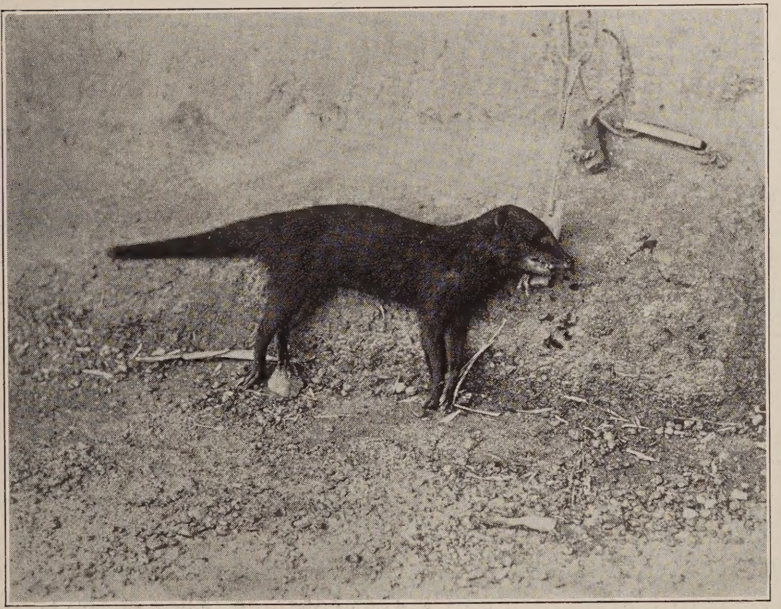
[1] Johnston: *Loc. cit.*, vol. II, p. 730.



No. 154. — *Tragelaphus scriptus*, harnessed antelope



No. 155. — *Ichneumon* (mongoose)

and enthusiastic interest in it, and devoted much of his time to collecting when not engaged in the photographic work of the Expedition. In Liberia some birds are virtually confined to the immediate vicinity of the streams or to the shores of lagoons and pools, but, a large proportion of them are, as might be expected, forest dwellers.

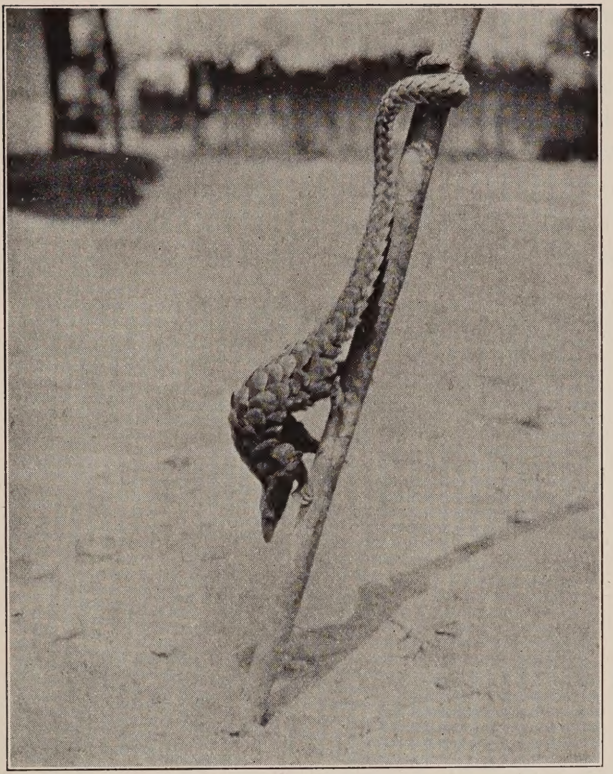
Büttikofer includes two hundred and thirty-one species in his list of the birds of Liberia. As revised and corrected, Dr. Allen's list comprises two hundred and eighty-one species and subspecies. He has accompanied each item with a very brief description especially designed to help any resident slightly familiar with birds to identify the specimens he may meet. He has also specified the range of the birds in Africa, given a summary of what has been published about them, noted the occurrence of the species in Liberia, and added such notes of the Expedition as seemed sufficiently important. Dr. Allen is to be congratulated on the results that he obtained; in spite of all the difficulties which were experienced in making the collection, he collected one hundred and thirty-seven species, twenty-one of which had not previously been recorded from Liberia.

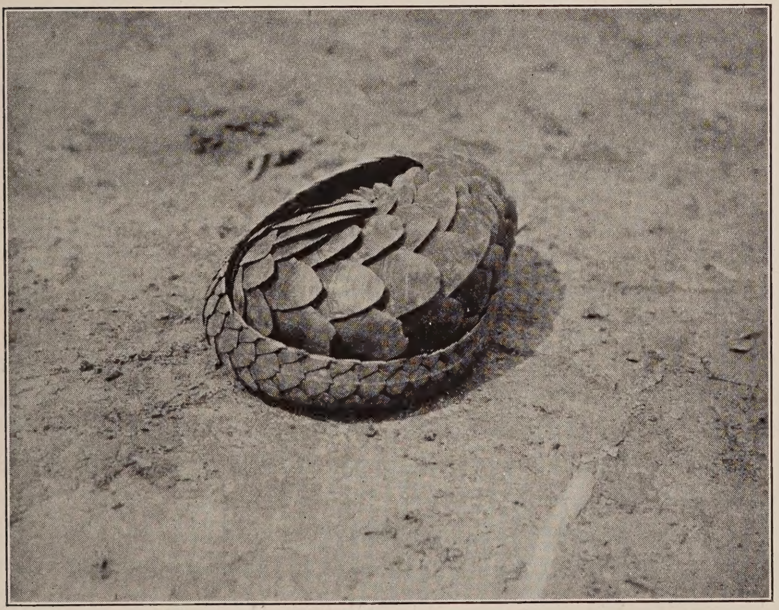
Parasites of the genus *Haemoproteus* were found in four birds: the barbet *Gymnobucco calvus,* in the kingfisher *Halcyon senegalensis,* in the bee eater *Melittophagus gularis,* and in *Pyromelana hordacea.* These are described in Chapter XXXIV.

Reptiles and Amphibians. Three species of crocodiles are found in Liberia. The *Crocodilus cataphractus* is still common. It differs from the more frequent African form, *C. niloticus,* not only in the slenderness of its snout, but in the proportional length of the bones of the upper jaw, and in its bony armour. A specimen measuring two and one-half meters in length was shot near our camp by Dr. Bouet on the Du River, some twenty-five miles inland. This species is rarely found nearer the coast in the regions where the water is brackish, and where *C. niloticus* is the commonest species. Crocodiles, however, like all other forms of wild life in Liberia, are becoming less abundant. The short-headed crocodile, *Osteolaemus tetraspis,* is readily identified by its very short, broad head and turned-up nose, and by its much smaller size. It does not exceed five feet in length. A specimen collected by Allen in the St. Paul River, measured 1043 millimeters. In *C. cataphractus* from the Du River, a severe infection of the blood with a species of haemogregarine was discovered.

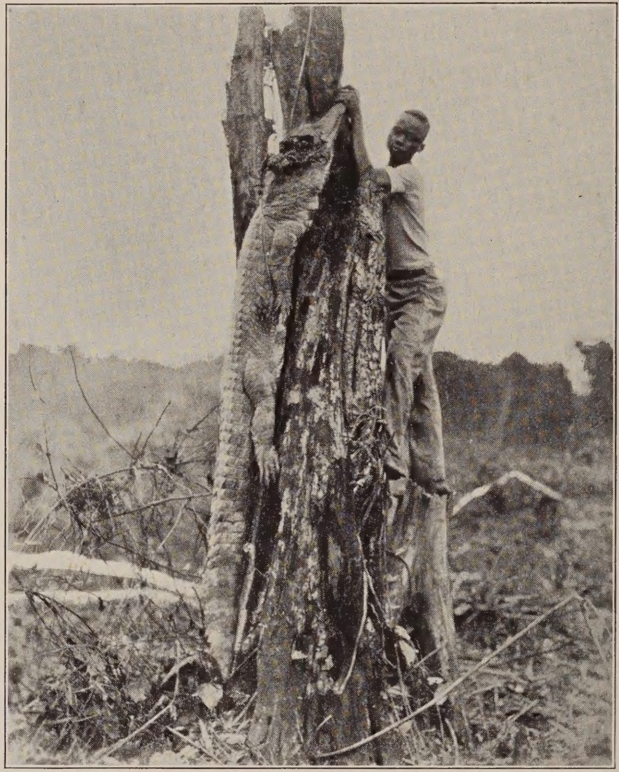
The reptiles of Liberia are numerous and there are at least ten common species of poisonous snakes. In spite of the fact that these poisonous varieties are frequently seen, deaths from snake bite are said to be very rare on the coast, and in the interior we met with no severe or dangerous cases. Barbour and Loveridge, commenting on the fact that venomous snakes appear to occur in greater numbers in Liberia than on the east coast, say that of the total number of species now known from Liberia, one in three is poisonous. Of the seventy specimens brought back by the Expedition thirty are dangerously venomous.

The most poisonous snakes of Liberia are the cobras *Naja nigricollis, N. melanoleuca* and *N. goldii,* the tree cobra *Dendraspis viridis,* and the vipers *Causus rhombeatus, C. lichtensteini, Bitis gabonica, B. nasicornis, Atheris chlo-*





Nos. 156, 157. — *Uromanis longicaudatus,* the arboreal pangolin *rechis* and *Atractaspis corpulenta.* Of the cobras, which are all large snakes ranging from four to eight feet in length, the *Dendraspis* is thought to be the most dangerous and the most likely to attack human beings if disturbed under certain conditions. A specimen found in our camp under the bed in Dr. Shattuck's tent measured six feet eight and one-half inches. The Causus viper, which is common in the country, is sometimes referred to as the "spitting snake" on account of its dribbling the venom from the point of its fangs when angry or disturbed. However, the natives sometimes also refer to the cobra as the "spitting snake," for some of the West African species, *Naja goldii* for example, are able to eject their venom to a distance.



No. 158. — *Crocodilus cataphractus*

C. rhombeatus is an olive brown viper only about two feet in length. It is nevertheless very venomous, and is all the more dangerous because of its insignificant appearance and size. *Atheris chlorechis,* a tree-dwelling viper often found in low bushes, is bright green in color. It also is a small snake, not over two feet in length.

The puff adders, *Bitis gabonica* and *nasicornis,* are variegated with black, yellow and brown, and grow to a length between four and five feet. They are frequently called by the natives "cassava snakes." *B. nasicornis* is known also as the horned puff adder or the rhinoceros puff adder, from the two little quill-like horns above the nostrils, which are often erected when the snake is angry or excited. In a specimen which was killed with a spear upon the trail, the nematode parasite *Ophidascaris filaria* described on page 426, was found in the intestine.

Atractaspis corpulenta, which is a shorter viper, perhaps three feet in length, and which is thicker in body, has poison fangs only in the front of the upper jaw and no other teeth behind. It is much less dangerous than the other four species of Liberian vipers.

The typhlopine snake, *Typhlops punctatus* (synonym, *T. liberiensis*), is common. This snake, which has become specialized for life underground, and which subsists especially upon insects and small worms, has nearly lost the use of its eyes which are very minute. The mouth, also, is small. The head is so like the tail that the natives often term it the "two headed snake." It bears considerable resemblance to the large blue-green earth worm so common in Liberia, with which it may be confused unless carefully examined.

Two species of python are found in Liberia, — *Python sebae* and *Calabaria reinhardtii.* The latter, sometimes called the burrowing python, was observed by Allen in the basin of the St. Paul River. It has a relatively small head and is rarely over four feet in length. The *P. sebae* is of course much larger; specimens twenty feet in length are not uncommon. In one of these pythons we found the two intestinal parasites, a cestode (*Bothridium ovatum*) and a nematode *Ophidascaris filaria* described in Chapter XXVII. In the lizard *Agama colonorum* and the bat *Petalia grandis, Plasmodia* were found in the blood. These are described on pages 492, 493.

The Expedition has been particularly fortunate in having had Dr. Thomas Barbour and Mr. A. Loveridge study the collection of reptiles and amphibians from Liberia, made by Dr. Allen and his associates. They point out that until now there have been but nineteen known species of amphibians recorded from Liberia, while thirty-three were secured on the present Expedition. As a result of their study of the entire collection they have found that it contains no less than thirty-three species, now recorded for the first time. They also have found that in the reptilian collection, in which forty-one species are represented, many are recorded also for the first time. Among them is the arboreal cobra, *Naja goldii.* Notes regarding the specimens with a list of the new species, are given in Chapter XXXV.

ENTOMOLOGY

Almost nothing was known of the entomology of the interior of Liberia prior to the present expedition and very little collecting of insects had been carried on in the country. The entomological work of the present expedition was planned not with the idea of making a miscellaneous collection of all orders of insects, but rather of obtaining as complete a representation as possible of certain groups interesting from a biological or pathological point of view — especially the blood-sucking Diptera.

Obnoxious insects are not so prevalent in Liberia, either on the coast or in the interior, as they are in many other parts of the tropical zone. Indeed, at certain seasons of the year, insects are comparatively rare. Not many blood-sucking insects were encountered on the rivers or along river banks, — a scarcity in striking contrast to the abundance of them found in certain other tropical countries, for example, along the Rio Negro and the Rio Branco in Brazil, where during many days clouds of simulium, *S. amazonicum*, inflicting troublesome and irritating bites are frequently met with. Mosquitoes although usually not unduly plentiful in Liberia either upon the coast or in most parts of the interior, are nevertheless not especially scarce, and, moreover commonly include such species as render them frequently dangerous to man. Eighteen species of mosquitoes were collected by Dr. Bequaert from Liberia and twenty-five from the Belgian Congo. The yellow fever mosquito, *Aëdes aegypti*, is especially common in and about Monrovia, and is particularly abundant at the beginning and close of the rainy seasons, that is, from April to May and from October to November. In fact, at these seasons it may be the most common mosquito. This mosquito, and also particularly *Anopheles* and *Culex fatigans*, were found breeding in many parts of the town and in its outskirts, particularly in the water in the back yards of the houses, in the gutters, at the sides of the streets and in the wells or cisterns used for drinking water. Most of the wells are open, and almost every yard in Monrovia has one. *Aëdes* was also found by Bequaert breeding in holes in fallen trees along the Du River in Liberia as far as some twenty miles inland. Obviously this mosquito is particularly dangerous potentially in such a community as Monrovia, where cases of yellow fever among the general population are not likely to be detected or recognized and of course not screened. Only when some person of prominence in the community has fever and other symptoms of the disease, is it at all likely for yellow fever to be considered. Bequaert agrees with Dyar in the opinion that *Aëdes aegypti* probably originated in the Old World and was carried by ships from Africa to America. There are, for example, several species of *Aëdes* of the subgenus *Stegomyia* in Africa (three in Liberia), whereas in America there is only one, *Aëdes aegypti*. As might have been anticipated, other species of *Aëdes* closely allied to *A. aegypti* have been shown recently by Bauer [1] at Lagos, West Africa to be capable of transmitting yellow fever infection in monkeys. In earlier years, Marchoux and Simond,[2] who attempted to transmit the disease to man by means of other species of mosquitoes, obtained only negative results. The five different species employed were *Aëdes scapularis*, *Aëdes taeniorhynchus*, *Culex quinquefasciatus*, *Psorophora ciliata* and *Psorophora posticata*. However, since it has been shown that *Macacus rhesus* monkeys can be infected with yellow fever virus, more extensive experiments in transmission can now be carried out than formerly when man only was known to be the host. Bauer has recently made experiments in transmitting yellow fever with seven different species of mosquitoes besides *Aëdes aegypti*, viz., *Aëdes luteocephalus*, *Aëdes apicoannulatus*, *Aëdes apicoargenteus*, *Aëdes longipalpis*, *Aëdes welmani*, *Culex nebulosus*, and *Eretmopodites chrysogaster*. The results are as follows:

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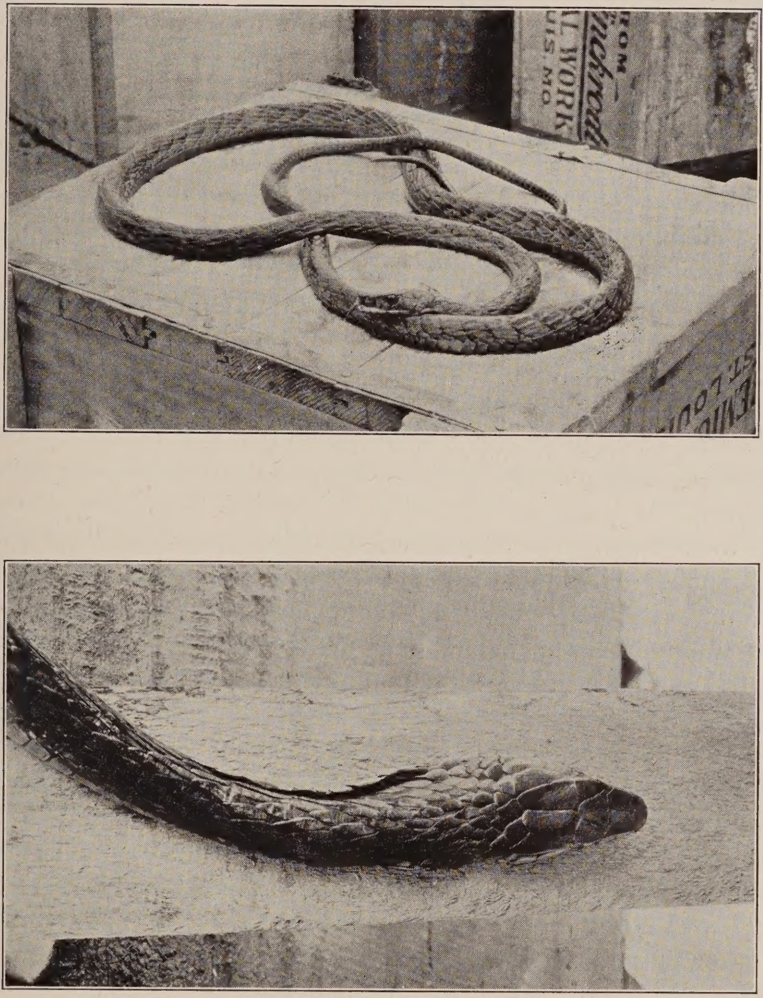
[1] Bauer: Amer. Jour. Trop. Med. (1928), VIII, 261, and Jour. A. M. A. (1928), XC, 2091.

[2] Marchoux and Simond: Ann. Inst. Pasteur (1906), XX, 16.



Nos. 159, 160. — Tree cobra, *Dendraspis viridis*, 6 feet, 8 inches

"1. *A. luteocephalus* and *A. apicoannulatus* were found to transmit the disease in all respects in the same manner as *A. aegypti*.

2. Two lots of *E. chrysogaster* were allowed to feed on infected monkeys. One of these lots produced typical infection when later fed on normal monkeys; the mosquitoes of the other lot failed to convey the virus through bite, but proved infective when macerated and injected into a normal monkey twenty-four days after their original infecting feed.

3. Attempts to transmit the disease with *A. apicoargenteus* gave entirely negative results, either through their bite or through being injected into normal monkeys at various intervals after they had fed on infected animals.

4. *A. longipalpis*, *A. welmani*, and *Culex nebulosus* failed to feed on infected monkeys, and consequently the question whether or not they can transmit yellow fever could not be determined.

5. The pathologic changes in the monkeys which died after being bitten by *A. luteocephalus*, *A. apicoannulatus*, and *E. chrysogaster* were typical of yellow fever, and the virus apparently suffered no loss of virulence by its passage through these mosquitoes."

It is possible, of course, that in a larger series of experiments some of the species of *Aëdes* which gave negative results might give positive ones. At least no one would be justified in rigidly excluding them as possible transmitting agents in yellow fever.

Philip[1] has still more recently shown that three other species of *Stegomyia* are capable of transmitting the disease to monkeys. These are *Aëdes vittatus*, *Aëdes africanus*, and *Aëdes simpsoni*. This brings the list of mosquitoes shown to be capable of transmitting yellow fever up to a total of seven.

Legendre[2] has maintained that there are two races of *Aëdes aegypti*, one a large insect capable of transmitting yellow fever, the other a small one of oceanic and Indian race incapable of transmitting the disease. However, from the investigations of Hoffmann[3] and Brug,[4] who performed cross-breeding experiments in Cuba as well as at Java, these two strains of *Aëdes* (one Cuban and the other Dutch East Indian), appeared to be identical. Hindle[5] also has shown that yellow fever can easily be transmitted from monkey to monkey through the bite of an Indian strain of *Aëdes aegypti*.

Of the other mosquitoes in Liberia dangerous to man, *Anopheles* and *Culex fatigans* were also found to be common. Of these *A. gambiae* and *A. funestus* are the most prevalent and are probably the species which are usually concerned in the transmission of human malaria in Liberia. The eighteen species of mosquitoes collected on the present Expedition in Liberia have kindly been studied and identified by Dr. F. W. Edwards of the British Museum. There are six species of *Aëdes*, two of *Anopheles*, and five of *Culex*. Bequaert has listed one hundred and twenty species and eleven varieties of mosquitoes from the Belgian

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[1] Philip: Amer. Jour. Trop. Med. (1929), IX, 267.

[2] Legendre: Presse Méd. (1929), XXXVII, 459.

[3] Hoffmann: Meded. Dienst Volksgezondheid in Nederl-Indie (1929), XVII, 182–183.

[4] Brug: *Ibid.*, p. 184.

[5] Hindle: Trans. Royal Soc. Trop. Med. and Hyg. (1929), XXII, 405.

Congo. One of these collected on the present Expedition is a new species (*C. ninagongensis*) (page 837).

In relation to the occurrence of filariasis and elephantiasis in Liberia, it may be remarked that *Culex quinquefasciatus* (*fatigans*), as it is in many other tropical regions, is probably more commonly concerned in the transmission of *Filaria bancrofti* in Liberia. This subject is more fully discussed on page 231. However, Edwards has demonstrated that complete development of *F. bancrofti* may also occur in *Taeniorhynchus africanus*, *Anopheles rossi*, *A. costalis* and *A. algeriensis*, as well as *Culex pipiens*. Of these *A. costalis* was found by Bequaert in Liberia.

Culicoides grahami and *C. austeni* which, as has been shown, can act as an intermediate host for the filarial parasite *Acanthocheilonema perstans*, were also collected during the Expedition. This parasite, which produces transitory tumors known as Calabar swellings, is referred to particularly in Chapter XVII.

In the British Cameroons, where infection of man with *A. perstans* is very common, Sharp found over seven per cent of the wild flies *Culicoides* naturally infected with this parasite.

It seems probable that the scarcity of mosquitoes in parts of Liberia at certain periods of the year may be due to the excessively severe showers of rain which occur there during the rainy season, and which through the force of their heavy raindrops and the rushing torrents that the heaviest of them produce, destroy many of their larvae.

Of the blood-sucking flies collected, twelve species of tabanids were encountered in Liberia, four species of tsetse flies, one black fly (*Simulium damnosum*), five species of stable flies (*Stomoxys*) and six species of bird flies (Hippoboscidae). Both species of *Chrysops* (the mangrove fly), *C. dimidiatus* and *C. silacea*, which have been demonstrated by Leiper and by Connal to be the carriers of the filaria *Loa loa*, have been previously reported as having a wide distribution on the West African coast. In addition another allied species of *Chrysops* was found during the present Expedition by Dr. Bequaert in the Belgian Congo.

Of the five species of tsetse flies in Liberia, four, *Glossina palpalis*, *pallicera*, *fusca* and *nigrofusca* were collected by Bequaert. *Glossina medicorum* has been previously reported by Austen as existing in the country. Tsetse flies were not found to be very plentiful anywhere in Liberia. A trypanosome was found in the abdominal and head segments of one specimen of *Glossina palpalis* collected at Tappi Town, but no cases of sleeping sickness were discovered in this place. *Simulium damnosum*, a small species of black fly, was not encountered on the coast and was first observed in the interior of Liberia where at some ninety miles inland it was found in abundance. The breeding place of this fly was also discovered in a swiftly-flowing stream near this same locality, the larvae and pupae of the fly being found upon both dead and living leaves immersed in the water and exposed to the current, as well as upon the sides of stones beneath the water (see page 856). In contrast to the tsetse flies, only the females of *Simulium* bite, and they are voracious blood-suckers and bite freely at all hours of the day in shady places, but not in bright sunlight. This fly has been found to constitute an intermediate host for the parasite *Onchocerca volvulus*, which in turn gives rise to subcutaneous fibroid tumors in man, a condition particularly discussed in Chapter XVII.

Calliphoridae, *Auchmeromyia luteola* Fabricius, which gives rise to the Congo floor maggot, was found in the interior of Liberia in several places, as well as in the Belgian Congo at Lulenga. The native Kpwesi name for the maggot of this fly is *mboro.* It lives and hides during the day in crevices or dust, on the earthen floors of the native huts, and at night it seeks and attacks sleeping human beings, engorging itself with blood. However, it does not inflict a particularly painful bite, and is not known to produce any other pathological condition or to transmit any disease.

On the other hand, *Cordylobia anthropophaga* gives rise through its larvae to a form of African dermal myiasis. This fly is thick-set, compactly built, and of an average length of 9.5 millimeters. The head, body, and legs show yellow markings. Its eggs are laid on clothing, or on any dust or faecal matter. The larva, when it hatches, wanders to human beings or certain animals and penetrates the skin by its buccal hooks. When full grown it may attain a size of two centimeters. It produces lesions with the appearance of a boil, with a central opening usually obscured by a crust through which there can often be seen a small amount of black material, the excrement of the larva. This lesion is most commonly located on the scrotum, thighs, or buttocks, and the infection is presumed to often occur at the latrine. Occasionally in natives the nodule may occur on the scalp or in the axilla, or even on the forearms. When the larva escapes or is expressed from the small nodule which it forms in the skin, if it does not die it pupates, and later the imago is produced. Rats, monkeys, goats, dogs, and cats may be attacked by this maggot and may serve as reservoirs for it.

Although Maughan[1] refers to the presence of *Cordylobia* (the tumbu fly) and the lesions it produces in man, in Liberia we were not able to obtain any evidence of it in the country. It is possible that it may occur on the northwestern border along Sierra Leone, since it is so common in the latter country in the dry season. Dr. Bouet, however, has not observed it during several years in Liberia, and if it occurs at all it is probably exceedingly rare, particularly since the high humidity which prevails throughout the year in Liberia is inimical to its existence.[2]

An insect of considerable importance to the traveller in the interior of Liberia is the driver ant, *Anomma* or *Dorylus,* which at times may be a terrible pest. These insects are not usually found in the larger towns near the coast. Civilization, cleared roads and the noise and bustle of city life may, it has been thought, have driven them away. They frequent those parts of Africa where the climate is moist and are not found in the dry regions. Winding streams of them often a mile or more in length and several inches in width, soldiers and workers, are not infrequently encountered along the forest trails in Liberia. Where these apparently unending streams of ants come from and where they are going is usually

[1] Maughan: "Africa as I have Known It" (1929); "The Republic of Liberia" (1920), p. 219.

[2] The aetiology and the pathological histology of the American form of dermal myiasis, caused by the larvae of the fly *Dermatobia cyaniventris,* I have previously discussed in the Medical Report of the Hamilton Rice 7th Expedition to the Amazon (1926), p. 36.

a mystery. In some instances, however, they appear to be in search of food and in others to be migrating. Their nests are believed to be in huge excavations near the roots of large trees. Sometimes the route, worn bare of vegetation by the passage of a long column of these ants, can be traced after it has passed. In some instances the column of insects, when crossing a trail or road, passes in a sort of depressed channel, the edges of which are lined with the soldiers, while the workers hurry along in the center. In other instances shallow tunnels or arches are constructed, under which the column passes. As is well known, these ants will invade a camp, a house or a village during the night and devour every edible thing within reach, including small animals such as rats, mice, cockroaches, lizards, and even poultry or other birds that are confined and cannot escape, and leave nothing behind them except clean-picked bones. Their method of attack on a moving animal, as, for example, a lizard, is very interesting. A large colunm of them will rush at the animal and then suddenly the whole band, those on the animal and those on the ground, will cling together and form a solid mass the weight of which the animal cannot drag and under which he cannot move. In a few seconds he is completely covered by a thick mass of ants and very soon entirely devoured.

There is little doubt that a human being, particularly a child, if caught by the ants when held a prisoner, and unable to move, would soon be devoured by them. Johnston states that it has been a common outlet for African cruelty to peg down men, women, or children across the path of the driver ants, to die a horrible and lingering death, and that he has seen in several parts of Africa, the corpses of negroes who have been killed in battle or have died of disease, half eaten by these ants. Not far from one of our base camps the hut of a rubber planter was invaded one night by these insects. The planter had been an amateur collector of a number of birds and small animals, some of which were also in his room. Most of these were devoured during the night. Throughout the night the man himself crouched upon a table the legs of which he had placed in vessels containing kerosene. Once driver ants started to invade our camp, coming apparently in billions over the stockade and through the crevices of the fence around the camp and forming very numerous columns along a front of from thirty-five to forty feet wide. We were able to turn the attack of this enormous army into a complete rout and hasty retreat by spreading a thick layer of petroleum on the ground along the front of the advancing columns. It was very interesting to observe the universal, quick retreat. Within fifteen minutes there was not an ant to be seen in the compound. Büttikofer[1] suggested that the remarkable scarcity of many types of insects and smaller pests and birds in Liberia might be due to the excessive numbers of both of the predatory driver ants, genus *Anomma*, and of the red tree ants, *Oecophylla*. The red tree ants are not so numerous as the driver ants and not so aggressive. Generally, they do not go very far from the trees in which they dwell but their bite is disagreeable and painful — all the more on account of the formic acid it leaves in the wound. They often make their nests in large leaves, which they roll into a cornucopia-like receptacle and many of which are full of the reddish yellow ants.

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[1] Büttikofer: "Reisebilder aus Liberia." Leyden (1890).

One also cannot travel far in Liberia without noticing the varied architectural work of the termites, or white ants, the most important tropical species of which are quite blind and do their work under ground. The species *Macrotermes natalensis* constructs ant hills or termitaries sometimes from six to eight feet high (No. 466). On account of the hard clay and cement with which they are constructed the hills are not easy to break into; in opening them one needs to be careful to avoid the bites of the thousands of soldiers which in a fearful commotion may immediately surround him. The queen is usually found in the center of the nest at the bottom, pregnant with many thousands of eggs and many times the size of her king and consort, who is likely to be buried under her abdomen. The history of the termite apparently dates back to a time some millions of years before man appeared on the earth. Many travellers in the early days of African exploration have described the depredations of the white ants, and Smeathman[1] as early as 1781 gave an interesting account of the termites found in Africa and made many valuable observations which have been amply confirmed. Maeterlinck in his recent entertaining and interesting book on "The Life of the White Ant" has written of these insects from a different standpoint. He remarks that the white ants present a model of social organization and that they have a civilization which is the earliest of any, and which is the most curious, the most complex, the most intelligent and in some ways the most logical and best fitted to meet the difficulties of existence which, until our own, had ever appeared on this globe. He discusses the social organization, the habits and the morality of the inhabitants of the termitaries, and philosophizes regarding their destiny from the point of view of the existence of the universal soul. In fact he has drawn from his story of the white ant a profound and moving philosophy of human life and its ultimate development and goal. The white ants in Liberia do not constitute the great problem that they do in many other parts of the tropical world as, for example, the Far East, and one does not see great evidences of their destructiveness in the houses of the Liberian towns on the coast. *Macrotermes natalensis* more commonly constructs its nests in more or less open places where the forest has been cleared. In the forest region and along the trails a commoner type of termite is encountered which is perhaps *Termes mordax*. This species builds small mushroom-like dwellings out of brown or bluish clay, more or less mixed with decayed vegetation. Some of them considerably resemble a mushroom with a cylindrical stem. Others, constructed in tiers, one mushroom on another, look like a miniature Japanese pagoda.

At certain seasons, the perfected male and female termites take to flight, sometimes in great clouds, for the purpose of mating, after which the females get rid of their wings and the males die. One or more of the fertilized females or queens eventually find their way to the nest in a wingless condition, where they are built into a large shell and fed from time to time. The eggs are eventually taken away by the workers. Reference has been made to the scaly ant-eaters or pangolins encountered in Liberia. Although Büttikofer found in the stomach of one of these ant bears a quart or so of termites, it appears that they do not usually eat termites but subsist largely upon the driver ants. While the pangolins devour enormous quantities of these true ants, they are not present in sufficient numbers to bring about any appreciable diminution of these insects in the forest.

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[1] Smeathman: Trans. Royal Soc. (1781).

Bees and wasps are also common in Liberia. *Apis fasciata* often builds its hives in hollow trees. This bee has a severe sting. While we were in Monrovia a small child was so severely stung by bees that it succumbed from the toxic effect. Among the larger invertebrates may be noted the occurrence of the scorpion *Pandinus imperator*, which is greenish blue, bluish black or, more rarely, a buff yellow in color. It is sometimes six inches in length and is capable of inflicting a very severe sting.

Johnston has also noted the presence in Liberia of thew hip scorpion, *Titanodamen bassamensis*. Among the spiders which also produce a painful bite are the large and hairy Mygalomorph (*Scodra brachypoda*) and a large scarlet or yellow and black spider of the genus *Nephila*. Lice are not very common in Liberia though both varieties *Pediculus corporis* and *capitis* were found. Neither ticks nor mites nor fleas are particularly troublesome in Liberia but near the coast the jigger or burrowing flea, *Sarcopsylla penetrans*, is not uncommon and occasionally invades the feet of natives. However, it is not nearly so prevalent as it is in many parts of its original home in South and Central America. *Pulex irritans*, the human flea, was not found, but a species of *Xenopsylla* (the plague rat flea) was collected in Paiata. All the fleas observed biting man were found to be *Ctenocephalus canis*, the common dog flea.

XIV

SANITARY AND MEDICAL CONDITIONS: PREVAILING DISEASES

In general, the history of Liberia has been simple in respect to hygiene and sanitation. Preventative measures have been few, and the survival of many of the Americo-Liberian people in Monrovia and the vicinity has often apparently depended in the main, on the tolerance or immunity which they have acquired in respect to infectious disease. The early history of the colony shows that a great amount of fever and sickness prevailed, and that the mortality was high. The first company of three Americans and eighty-eight freed negroes who sailed for the coast one after the other were attacked by sickness shortly after they landed, and all of the Americans and a large proportion of the negroes died. The following year the three American agents sent out to the colony, Andrews and Winn and his wife also succumbed to illness. It may also be remembered that in 1821, Gordon, a young midshipman who came to the aid of Ashmun at Mesurado, was attacked with fever, and he and eight of his men died within a month of the time of their landing. A short time afterwards, Captain Spence of the U. S. S. "Cyane," who stayed at Mesurado for several weeks, lost his surgeon, Dr. Dashiell, and some of his men from disease. The extraordinary susceptibility of the new settlers to fever and to other tropical diseases is frequently referred to in the history of the colony. Of one hundred and five immigrants arriving on one vessel, all were attacked with fever within a month of landing. Mrs. Ashmun also died and Ashmun himself, after a severe attack of fever was sent home on the advice of a physician and died in 1828.

The late Dr. Frederick C. Shattuck called my attention to several notes from Ashmun's journal contained in the life of Ashmun written by Randolph Gurley.[1] These notes today seem of considerable significance. "Emigrants by 'Doris' were heavily afflicted; season unhealthy; their passage nearly twice the usual length. In the case of twenty-four from Maryland, the disease baffled all the medical skill existing in the colony." "Emigrants by the 'Randolph' and 'Nautilus' suffered slightly. Of the one hundred and seven by 'Doris,' twenty-four died, all from the North Potomac. Draw a line due east and west across the Elk Ridge, Maryland, and not a death has invaded the people from the south of it."

One can today only speculate whether the sickness and mortality among the settlers which Mr. Ashmun refers to was due to malaria or to yellow fever or to both. At that time the malarial parasite had not been discovered, and diagnosis was not accurate. However, the idea suggests itself that many of the persons coming from south of the Potomac had acquired — perhaps through previous attacks of the disease — a greater tolerance or immunity to the malady so prevalent and fatal at Mesurado at that time, than those coming from the northern part of the United States.

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[1] Gurley: Life of Jehudi Ashmun (1835).

Undoubtedly many among the population of Liberia of today have through long residence either become more or less immune both to malaria and to yellow fever, or have acquired greater tolerance to these and certain other infectious diseases prevalent in tropical countries, for otherwise there would be a higher morbidity and higher mortality among them from such affections.

The situation in the matter of sanitation is perhaps unique. There is among the Liberian people no health organization of any sort anywhere in the country, no public health laboratory of any description, and no adequately trained sanitarian or physician. The Government had selected a two-storied house formerly used as a residence in Monrovia, as a hospital while we were there, and had placed in it a few beds, several of which were occupied by patients in charge of a poorly qualified Liberian physician and a Liberian nurse.[1] This apparently is the only gesture that the Liberians have made with reference to the question of hospitalization and the care of the sick. In Monrovia there is no general system of sewage, disposal or drainage, no running water in the houses, and no general water supply. The drinking water is derived from wells and cisterns, and in the porous soil of the same back yards are both the well or cistern and the latrine. The latrines are not protected from flies. *Anopheles*, *Stegomyia*, and *Culex* (*fatigans*) mosquitoes were found breeding plentifully in many parts of the town and on its outskirts, particularly in the gutters at the sides of the streets, in the water in the back yards, and in the wells or cisterns in the yards. Food, both raw and cooked, is commonly exposed for sale in the open-air restaurants along the main business street, and is never protected from flies. Only in several houses of the whole town has any screening against insects been done, and mosquito nets are not in general use at night. That more residents are not actually ill, and that there is not a higher morbidity and mortality from dysentery, typhoid fever, malaria and filariasis is obviously due in part to tolerance and immunity. There are, of course, no public health statistics, no records of illness, births or deaths. However, our examination of the Kru children at Monrovia gave evidence of the high rate of infection with malaria among them, as no less than eighty-seven per cent were found to have malarial parasites in their blood. Since the majority of the children were not confined to bed, but were up and about, and showed little evidence of disease, it would appear that many of them had already acquired more or less immunity to the action of the malarial parasite.

Medical Conditions in Liberia. The medical and sanitary responsibilities in Monrovia for some years past have fallen upon two European doctors residing in that city, — Dr. G. Bouet, who has also acted as Chargé d'Affaires and French Consul for Liberia, and Dr. Fuszek, an Hungarian physician practicing in Monrovia. Fortunately both of these gentlemen have special knowledge of tropical diseases. At Muhlenburg, some fourteen miles north of Monrovia, there is a hospital of the Lutheran Church connected with the Mission. Owing to much sickness and disability among the staff and their consequent absence from duty, not very active work was being carried on at the time of our visit.[1]

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[1] Since the above was written, and as a result of considerable pressure, I am informed a Government hospital has been established in the building of the abandoned German cable station at Monrovia, containing about twenty beds, and with fairly modern equipment but still without a properly qualified physician.

Since Mr. Firestone has established the Firestone Plantations Company in Liberia, several American physicians have been maintained in connection with it. Dr. Paul Willis, who was Medical Director for the Company while we were in Monrovia, and who assisted us in many ways, was compelled on account of ill health to return to the United States. Dr. Justus B. Rice has succeeded him as Medical Director of the Firestone Plantations Company, and since Dr. Bouet's departure to Cape Palmas, it is on him that the medical and sanitary work of Monrovia has largely devolved. Dr. Rice and his two assistants have been able to care medically for all of the employees of the Firestone Company, as well as to give assistance to many others.

There was no doctor of medicine in the interior of Liberia and no pharmacy of any description. The Holy Cross Mission has established a small hospital at Masanbolahun near the Sierra Leone border, not far from the head of the Sierra Leone Railroad at Pendembu, and Dr. Edgar Maass, a German physician has recently been placed in charge, but was absent on leave when we were in Liberia.

There had been no published record of medical conditions among the tribes in the interior of Liberia, or of the diseases particularly encountered there, prior to our visit. In order to obtain as complete an idea as possible of the extent and character of sickness in the interior of the country, a clinic was established in each village or town that we visited. Through interpreters it soon became known that there were white "medicine men" among the members of the Expedition, and the people, naturally very curious and also generally trustful, came in large numbers to be treated for their various ailments. Parents often brought their sick children. At the stations the patients were first studied from a clinical standpoint and then subjected to microscopical and other laboratory examinations for diagnosis, and the needed treatment and medicine given them. Whenever the opportunity presented itself, microscopical and clinical examinations were made of large groups of people, both adults and children, particularly with reference to the detection of animal parasitic infections and to discover early or latent disease. Such examinations were carried out on children in the schools of Tappi Town, Cape Mount, and Monrovia. A large number of pathological lesions were excised and preserved for sectioning and later microscopical study. As house to house inspection was also made in the villages in order to detect other cases of disease, very few sick in the vicinity escaped our notice.

The villages themselves are on the whole clean. In general the houses are not dirty, in spite of the fact that chickens and goats about the towns enter the huts freely and frequently sleep in them. The houses seem to be swept clean each

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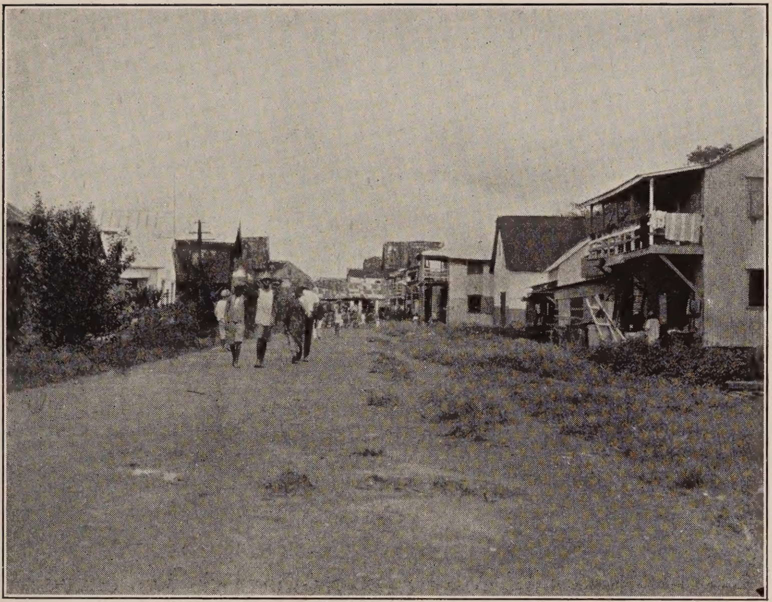
[1] Since our return we have been informed that a physician has also been attached to the clinic of the Protestant Episcopal Mission at Cape Mount, and also that Dr. Wehrle, a German physician, has taken up private practice in Monrovia.



No. 161. — Streets and gutters in Monrovia, breeding places of mosquitoes

No. 162. — Monrovia, rural sanitary arrangements

day. The great majority of the villages in the interior have no latrines and the natives retire into the bush or forest. Where the inhabitants have come more into contact with civilization, latrines or pits are sometimes made use of, and may be screened by thatch.

Prevailing Diseases. The diseases chiefly encountered in Liberia are malaria, blackwater fever, filariasis, elephantiasis, onchocerciasis, juxta-articular nodules, schistosomiasis, leprosy, yaws, syphilis, granulomatous and ulcerative conditions of the skin, smallpox, chicken pox, parasitic infections of the skin, ainhum, intestinal parasitism, amoebic dysentery, tuberculosis, and diseases of the genital organs, particularly gonorrhoea. Among the diseases more rarely encountered are pneumonia, bronchitis, pleurisy, bacillary dysentery, typhoid fever, rheumatism, trypanosomiasis, yellow fever, beriberi, and nutritional disturbances. Neither bubonic plague nor relapsing fever are found.

Dr. Jourdan [1] reported upon the diseases he encountered among the militia and Liberian Frontier Force which was sent in 1910 to put down the disturbances among the Grebos near Cape Palmas on the Coast. In his report he mentions the following diseases as most common; gastric disturbances, ulcers of the legs, malaria, diseases of the respiratory tract, lymphangitis, and oedema of the legs. Gonorrhoea was also frequently observed, but the cases were almost always chronic and imported from Monrovia. Some acute cases, however, were noted. Disturbances of the heart due to over-exertion, conjunctivitis, periostitis and odontalgia were the disturbances most frequently complained of. Although little attention was given to the sterilization of drinking water, only ten cases of dysentery occurred. There were only eight cases of beriberi observed.

Maass [2] has also reported very briefly upon the diseases he observed at the Missions Hospital at Bolahun, in Liberia, which is situated some forty miles from the Sierra Leone border and near the head of the Sierra Leone railway. He mentions malaria, yaws, ancylostomiasis and schistosomiasis as being the commonest ailments in the region. Leprosy, ascaris and trichuris infections were also common. He states that hookworm infections were relatively rare and that severe anaemia which could be attributed to hookworm was seen only in three cases. He also observed juxta-articular nodules, onchocerciasis and rhinopharyngitis mutilans, the last of which was associated with two cases of goundou. Blood filariae were found to be rare, and no case of trypanosomiasis was observed. Tuberculosis was exceptional.

The more important diseases which we observed in Liberia and which we specially investigated, are described in Part II, page 210.

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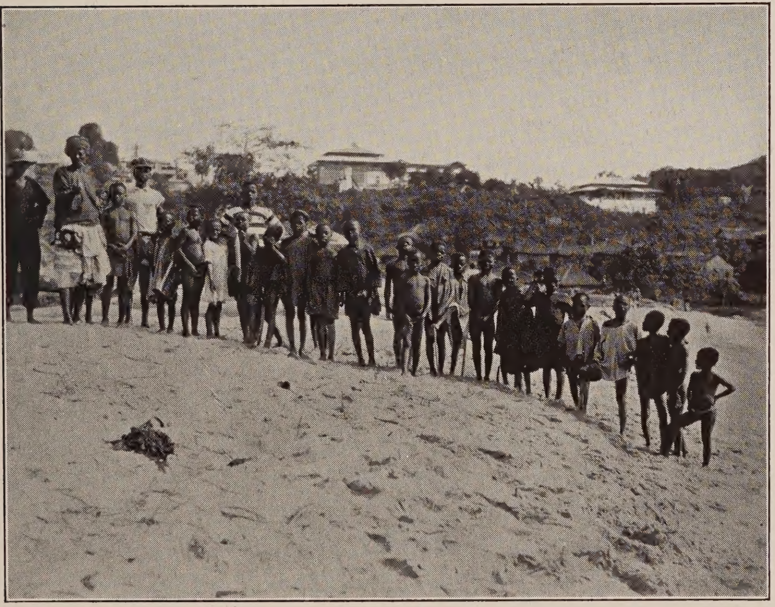
[1] Jourdan: Ann. d'Hyg. et Méd. Coloniales (1912), July and October.

[2] Maass: Abhandlungen aus den Gebiet der Auslandskunde, Bernard Nocht Festschrift (1927), p. 268. Jour. Trop. Med. and Hyg. (1928), XXXI, 102.



Nos. 163, 164. — Medical survey of groups of Kru children, 86 per cent infected with malaria

XV

SOME PROBLEMS CONCERNING THE WELFARE OF THE PEOPLE

From this summary of the social, biological, and medical conditions which exist in Liberia, it will be seen that certain problems stand out in respect to the welfare of the people and the further development of the country. Progress in Liberia, since 1847, when the country became independent, has obviously not been great. The conditions under which the great majority of the people live probably do not exist elsewhere, — certainly not elsewhere in the civilized world. The political situation is plainly most unfortunate. Although Liberia is an independent republic, it is evident from the conditions described in this Report that there is little freedom for the great majority of the people who reside in the interior. Although for the most part they are very backward and unenlightened, and are subjected to various forms of oppression and exploitation, some of them are nevertheless among the most superior people in Africa, and evidently capable of considerable advancement.

There is no known country of the size of Liberia where there is no proper government hospital and where there are no properly qualified government physicians, and where sanitary and medical conditions have been almost entirely neglected; and where, moreover, there is no laboratory in which the diagnosis of infectious disease can be made, and in which, for example, a case of yellow fever may be differentiated from a case of severe malaria. Without the assistance furnished from time to time by the physicians of the Firestone Plantations Company in Liberia, or by Dr. Fuszek, a Hungarian physician in private practice in Monrovia, even the foreign residents of the capital would be without medical assistance of any nature.[1]

One cannot refrain from comparing certain conditions which exist in Liberia with some of those which exist in the neighboring British Colony of Sierra Leone. The comparison is of some interest, because Sierra Leone like Liberia was settled with the idea of founding a home for freed slaves and their descendants. Sierra Leone, with about the same population as Liberia, has more than four times the amount of trade and revenue. The per capita expenditure, revenue, and trade in Liberia are much the lowest in Africa. Liberia also has six times the public debt of Sierra Leone. The latter country expends more than twenty times the amount expended by Liberia on education, and on medical and agricultural work. The Sierra Leone Government maintains a medical staff of twenty-two officers, whereas the Liberian Government maintains but one poorly-trained Liberian physician at Monrovia, and one building called a hospital, in which there were two or three patients at the time we were in that city.

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[1] See footnote, page 200, regarding Dr. Wehrle.

Except for an appropriation of some $18,000 largely for the salaries of school teachers, the Liberian Government spends almost nothing on the improvement of the condition of the people. The greater part of the customs revenue, together with most of the hut taxes imposed on the natives of the hinterland, the second largest source of government revenue, is expended particularly on governmental salaries.

It is interesting also to compare certain conditions in Liberia with those which exist in the Philippines. Anyone familiar with the state of affairs that existed in these Islands before 1898, and with conditions as they are today, cannot fail to appreciate the wonderful improvement that has taken place since American intervention. The progress made in the last thirty odd years has recently been recorded in a dispassionate and most authoritative and convincing way by the Hon. W. Cameron Forbes in his history of "The Philippine Islands," 1928. In that work he has also told of the victories in sanitation which have been achieved there, and described the medical and sanitary care provided by the Government for the people throughout the Islands.

It is true that occasionally one hears the question of independence for the Islands raised by a few Filipino politicians or by a handful of other persons interested in a public discussion of the matter. But the advisability of independence of the Philippines sinks into insignificance when one considers the marvellous change, and the justice and freedom and contentment that have come about through American administration. Anyone who has resided for any length of time in the Philippines knows that an atmosphere of freedom prevails throughout the country, and that moreover, the people are virtually independent, and indeed enjoy more freedom than the people of the United States. Such a condition obviously does not exist in Liberia for the great majority of the interior people.

It is worth while also to compare the conditions in Liberia with those which exist in the only other negro republic, Haiti. Although the class of Haitians who have dominated affairs in that country seem to have failed in establishing and maintaining a competent independent government, there is no question whatever of the improvement in general conditions in the country, and in the welfare of the people, as well as in their health and in the better care of the sick and afflicted which has taken place in the Island since American intervention. These facts are convincingly set forth, not only by H. P. Davis in his "Black Democracy," 1928, but also in the annual reports of the Director-General of the Public Health Service of Haiti.

The United States has met, and is continuing to meet the unavoidable problems in connection with the welfare and development of the Philippine Islands and Haiti, in a highly satisfactory manner.

In regard to Liberia, it also is clear, that even in recent years the United States has from time to time evinced not only a friendly but a protective interest in the financial problems of that country, in her boundary disputes and internal disturbances, and in many other problems. Secretary of State Root,[1] in 1910, frankly referred to Liberia as an American colony. However, although our attitude toward the European countries with reference to Liberian problems has been one of "hands off," we have not, at least in some respects, accepted any definite responsibility. Perhaps the chief criticism to which our attitude is open is that in recent years we have on the whole left Liberia too much alone, and not given the country needed guidance and cooperation in many of her internal affairs. In view of the other governmental problems that faced the Americo-Liberians, it was apparently too much to expect that they should much concern themselves about the welfare of the indigenous natives. Indeed, the temptation to exploit the natives has at times evidently been too great to be resisted.

On the other hand, in judging the attitude of the United States toward this problem, it should be borne in mind that the actual conditions in the interior have not been well or widely known, and that there have been almost no American travellers who have observed the interior and described the conditions existing there. Reference has been made to the fact that during President Taft's administration a commission was sent to Liberia to investigate certain governmental conditions, but this commission did not personally investigate the state of affairs in the interior of the country.

Since our return from Liberia to the United States, we have naturally felt it incumbent on us to bring to the attention of those in authority and interested in the welfare of the people of that country, certain unfortunate conditions which exist, with the hope that something might be done to improve them. The governing classes in Monrovia have realized that the expenses of the government of Liberia, in excess of the customs receipts, internal and unassigned revenues, will in time have to be met with the increased taxes which can come only from increased industrial activity.

Many suggestions have been made in the remote past as well as recently by Monrovian politicians as to how the natives can be forced to supply greater and greater revenue. But, no one has stressed the responsibility of the Americo-Liberians toward the indigenous people. Clearly, the most important source of internal revenue for the Government lies, as we have seen, in the labor that the natives of the interior can furnish and the taxes that they can pay, but they receive from the state practically nothing in return for their taxes. We have emphasized the fact that many of them are forced to work for the Government for nothing, particularly on the farms and roads, or as porters, and that others are held as pawns.

The situation has recently become more complicated for the governing class because many of the laborers who have hitherto been compelled to work free, now realize that an opportunity is offered them by the Firestone Plantations Company to escape from the servitude in which they have been held, and to receive protection from abuse, as well as just remuneration for their services. When these laborers arrive at the Firestone plantations they are either given an opportunity to construct their huts for themselves, or are housed in those model villages with sanitary kitchens and latrines which the company has already constructed. They are furnished with proper food at cost and any medical attention or treatment that they may need. Naturally, many of the natives in the vicinity have flocked to the Firestone plantations to avail themselves of the improved opportunities that they offer. The result is that some of the government officials have recently complained of the difficulty in obtaining free labor for government work in some of the districts where the people have learned of the opportunities offered by the plantations company. During the year 1928 the Firestone Plantations Company expended alone in wages for laborers in Liberia the sum of $1,024,050.00.[1]

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[1] Root: Foreign Relations of the United States (1910), p. 700.

Through the assistance which, in many ways, Mr. Firestone has recently extended to Liberia, the country can now look forward to general improvement. The present time, therefore, seems opportune to those interested in the welfare and development of Liberia, as well as in the welfare of mankind in general, for a careful consideration of the important question of the relationship between the governing people and the indigenous tribes.

Ex-President Coolidge during his administration said that as time goes on the spirit of mankind is more and more demanding that government and society be conducted under the laws of truth. When discussing with him conditions in Liberia during the period of his administration, and also when conferring with Secretary of State Kellogg and Assistant Secretary of State Castle on the subject, the writer was impressed with the fact that both the President and our State Department were much concerned to seek ways and means the most efficient, to improve the existing conditions in Liberia, and to extend all possible friendly assistance to the country. Under the terms of the new Liberian Government loan, and by the appointment of an efficient American personnel to the positions authorized by it, it became possible recently to render further American assistance to the country.

The truth about the conditions which prevail in the interior must sooner or later become generally known. Liberia is a member of the League of Nations, and for some time it has seemed obvious that an investigation would be requested by that body, of certain Liberian affairs. The quiet insistence of our State Department has finally brought this to a realization. Since the writing of this Report, Washington has announced that the United States will soon join with the League of Nations in investigating the "slavery" situation. Our Government several weeks ago sent to Liberia Mr. Henry Carter of the Western European Division of our State Department, as Chargé d'Affaires at Monrovia, with general authority to supervise the investigation for this Government. The Commission of Inquiry into the charges that slavery exists in Liberia or that forced labor conditions exist there, is to consist of three members, — the Liberian Government selecting one, the United States a second, and the League of Nations a third. As the American member, the State Department has appointed Dr. Charles S. Johnson, a negro Professor of Social Science at Fisk University.

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[1] Message of President King to the Liberian Congress, 1929.

Dr. Cuthbert Christy has been selected as the representative of the League of Nations. The Liberian member will, of course, also be a negro.

In his Annual Message to Congress, 1929, President King of Liberia says in part:

> "In the month of June, the American Minister at this Capital, acting upon instructions of his Government, called at the Department of State and handed to the Secretary a note dated June 8, 1929, couched in no uncertain terms but yet friendly in tone, advising the Liberian Government that there have come to the attention of the Government of the United States, from several sources, reports bearing reliable evidence of authenticity which definitely indicate that existing conditions incident to the so-called 'export' of labor from Liberia to Fernando Po had resulted in the development of a system which seems hardly distinguishable from organized Slave Trade. It was further asserted that the reports which had reached the American Government of State indicated that these conditions of forced labor were general throughout the Republic, particularly in the interior, where forced labor procured with the assistance of the Liberian Frontier Force and high Government officials has become a common and usual practice."

After discussing the labor agreement between Spain and the Liberian Government, with reference to the sending of laborers to Fernando Po, he adds:

> "It is not easily apparent as to what is intended to be implied in the further statement (in the American Note) to the effect that conditions of forced labor are not confined to labor exported to Fernando Po but are general throughout the Republic of Liberia. As this allegation perhaps is made in connection with the policy pursued by the Liberian Government in the construction of its public roads, it would seem permissible to point out that the use of compulsory labor for public purposes is an act not peculiar to the present Liberian Administration. It has the sanction of the laws of the Republic and is not repugnant to the provisions of the Slavery Convention of 1926 as found in Art. 8, sub-section 1 of that Convention, which reads as follows: 'It is agreed that subject to the transitional provisions laid down in Paragraph 2 below, compulsory or forced labor may only be exacted for public purposes'."

As an evidence of recent further interest of the United States in aiding Liberia, our Government has delegated Dr. Howard Smith of the United States Public Health Service, as Health Officer at Monrovia, and Col. George W. Lewis, recently Chief of Internal Police of Porto Rico, as the senior officer, to take charge of the reorganization of the Liberian Frontier Force.

After our Expedition returned, Buell, who visited Monrovia, published information on the Native Problem, which he collected from interviews with different persons in that city and from various published documents. He did not go himself into the interior, and it is exceedingly unfortunate that he attempts to draw many conclusions regarding conditions in Liberia that he did not observe himself. Many of his statements are merely expressions of erroneous opinion. Many of the conclusions he draws about the welfare of Liberia, about the policy of the United States toward that country, and about the benefits to be derived from the assistance which Mr. Firestone has rendered Liberia, are wrong, and convey a mistaken impression of the facts. Nevertheless, in other respects, the report is most valuable for much of the extensive documentary evidence that he has collected is reliable and serves to emphasize the unfortunate conditions which prevail. Since the writer has had opportunity not only to observe some of the improved conditions which have come about in Liberia as a result of Mr.

Harvey S. Firestone's interest and activities there, but also to confer repeatedly with him and with his son, Mr. Harvey S. Firestone, Jr., with reference to their future plans for the country, he is thoroughly convinced that the opportunities of future development thus offered to Liberia and her people are unusually hopeful. Certainly without such assistance as Mr. Firestone offers or some other substantial aid (which apparently was not likely to be forthcoming), the future of Liberia during the next few years would have been more or less precarious.

PART II

MEDICAL AND PATHOLOGICAL INVESTIGATIONS IN LIBERIA AND THE BELGIAN CONGO

By RICHARD P. STRONG and GEORGE C. SHATTUCK

XVI

INFECTIOUS DISEASES

Malaria

Attention has been called to the high rate of infection with malarial parasites that we found in Liberia among the Kru children on the coast. Of a group of thirty-six children, thirty-one, or eighty-six per cent, showed malarial parasites in the blood. The great majority of these children were up and about. Some no doubt at times had distinct malarial paroxysms with chills and fever, but the majority showed no other marked evidence of disease at the time they were examined except that in thirteen, or thirty-eight per cent, the spleen was palpable. However, no case of marked splenomegaly, with the lower border of the spleen reaching to the level of the umbilicus, for example, occurred among them. It is impossible to say what percentage of these children acquire a high active immunity against malaria in adult life and what percentage acquire only an increased tolerance to the toxin of the malarial parasite.

In Roumania, Ciuca, Ballif and Viéru[1] have recently concluded as the result of 297 observations made during the therapeutic inoculation of persons suffering from diseases of the nervous system with blood containing malarial parasites, that immunity to malaria is not uncommon in that country, where the disease is prevalent and some 900,000 persons are infected.

We of course saw cases of active malaria in adult Americo-Liberians, with chills and fever, whose long residence had not rendered them thoroughly immune or entirely insusceptible to the action of the malarial toxin.

In the interior of Liberia, in people living between the St. John and the Dukwia River, who were examined at random and who were not ill with fever, thirty-three per cent of the inhabitants were found to be infected with malarial parasites and sixteen per cent showed more or less enlargement of the spleen. Among these apparently moderately healthy people, no infections were encountered where the number of malarial parasites found was large. From our investigations it seemed apparent that there is less malaria generally in the interior of Liberia than upon the coast. The amount of infection certainly varies in different localities in the interior, but we found no fever-ridden settlements, and no

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[1] Ciuca, Ballif and Viéru: Arch. Roumaines Path. Expér. et Microbiol. (1928), I, 577.

No. 165, Bassas (Fig. above) and No. 166, Grebos, (Fig. below) who were examined for malaria marked evidences of the ravages of malaria in any of the villages we visited, similar to what is sometimes seen in some South American towns, nor was the prevalence of mosquitoes as great in Liberia.

It is interesting to compare the high rate of infection with malaria in Monrovia (in children, 86 per cent), with that observed by MacDonald[1] in the adjacent country at Freetown, Sierra Leone. He found splenic indices of 50 per cent in an endemic and 72 per cent in a hyperendemic area, while the parasitic rates were 41 per cent and 72 per cent. Of 49 boys examined up to seven times, 98 per cent showed malarial parasites. In Senegal, at Dakar, Leger and Nogue[2] found the endemic index in adults with parasites in the blood in the wet malarial season in Dakar to be 47.5 per cent, and in children under two years, 64 per cent. Durieux and Sall[3] also found that the rate of infection in children diminished with the age, a percentage of infection of 50 in children of less than five years of age diminished to 34.3 in those of five to ten years and to 20.5 in those of ten to fifteen years. Under prophylactic measures the index for malaria in some localities was reduced from 50 to 24 per cent. Barreto,[4] in the study of endemic indexes of malaria in Portuguese Guinea, found that of 236 natives, 32 per cent were parasitized with the haematozoa of Laveran. The plasmodial index at Baloma was 57 per cent and at Buba 42 per cent. The splenic index, however, was always below this amount. The rate of infection with the parasites was found to vary greatly with the season of the year.

Ledentu and Vaucel[5] found, near Brazzaville, in the examination in seven villages, of 153 children, less than five years of age, that 36 per cent of them were infected with malarial parasites. The splenic index was higher in the younger children. The parasitic index, however, was always greater than the splenic index. Of 283 natives that were infected with malarial parasites, in 63 the spleen was enlarged (22.2 per cent), but in 220 the spleen was not enlarged (77.8 per cent). In the examination of 891 natives who had no parasites in their blood, the spleen was enlarged in 113 or 12.6 per cent. They found that the enlargement of the spleen was more common in *Plasmodium vivax* infections. Of these 645 had a large spleen and 143 no enlargement.

In our medical survey made of the Bassas, Grebos, and Kpwesi tribes, in which 33.33 per cent were found to be infected with malarial parasites and sixteen per cent with enlargement of the spleen, here again no case of very pronounced splenomegaly was encountered among them.

Almost no one doubts the value of the splenic index as affording a simple and rapid method of estimating the degree of malaria in some infected areas, but on the other hand it certainly does not furnish a means of discovery of all malarial infections, and it would be exceedingly unwise in certain tropical districts to assume that all cases of splenomegaly are necessarily malarial in origin.

Dr. Shattuck, on the present Expedition, concluded from his clinical studies in connection with our blood examinations that splenic enlargement does not seem to be a reliable indication of malaria in Liberia. A negative spleen does not exclude malaria in Liberia, while an enlargement of the spleen was not uncommon with a negative blood examination (see Tables I–III).

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[1] MacDonald: Ann. Trop. Med. and Parasit. (1926), XX, 239.

[2] Leger and Nogue: Bull. Soc. Path. Exot. (1923), XVI, 281.

[3] Durieux and Sall: Bull. Soc. Path. Exot. (1929), XXII, 618.

[4] Barreto: Bull. Soc. Path. Exot. (1927), XX, 280.

[5] Ledentu and Vaucel: Bull. Soc. Path. Exot. (1927), XX, 722.

TABLE I

BLOOD AND SPLEEN SURVEYS

Place	*Date*	*Parasites +*	*Spleen +*	*Total Blood Cases*
Kru Town	July 21	31–86 %	13–36 %	36 children
Du No. 3	Aug. 4–12	16–33 %	8–16.6%	48 men
Reppo's Town	Aug. 29	0	2–40 %	5 children
Zeanschue	Sept. 3	2– 9.5%	3–14 %	21 adults
Suahkoko	Sept. 4	1–10 %	1–10 %	10 adults
Tappi School	Oct. 3	0	7–29 %	24 boys *
Cape Mount	Nov. 14	4–13.4%	1– 3.4%	29 boys
Totals		54	35	

* Twenty-four boys were examined at the School but blood was taken from only seven, all of whom had enlargement of the spleen.

Total Blood Examinations — 156 of which 54 were positive. *Index* — 34.6%

Total Spleen Palpations — 173 of which 35 had enlarged spleens. *Index* — 20.2%

TABLE II

Place	*Spleen + Blood neg.*	*Blood + Spleen neg.*	*Blood and Spleen +*
Kru town	0	18	13
Du No. 3	7	15	1
Reppo's Town	2	0	0
Zeanschue	2	1	0
Suahkoko	1	1	0
Cape Mount	1	4	0
Totals	13	39	14

TABLE III

CONSOLIDATED SURVEYS

Spleen and Liver Examinations in Liberia

Place	*Date*	*No. of Cases*	*Spleen +*	*Spleen + +*	*Liver and Spleen +*
Kru Town	July 21	36 children	10	2	1 1 Spleen — 0
Du No. 3	Aug. 4–12	15 men	3	0	0
		19 "	2	3	0
		14 "	0	0	0
		9 "	1	0	0
		10 "	4	0	0
		13 "	1	0	0
Reppo's Town	Aug. 29	5 children	0	1 Spleen — 1	0
Reppo's Town	Aug. 30	5 adults	0	1	0
Zeanschue	Sept. 2	9 "	0	0	–
Zeanschue	Sept. 3	12 "	0	3	–
Suahkoko	Sept. 4	9 "	1	0	–
Tappi	Oct. 3	24 boys	6	0	0
Cape Mount	Nov. 14	29 "	0	1	0
Totals		209	28	10	

Spleen +	13.4%
Spleen ++	4.7%
Spleen +++	0.47%
Splenic Index	18.57 or 18.6%

While there has been considerable difference of opinion expressed from time to time about the value of the splenic index in the diagnosis of malaria, temperature curves, cyclic manifestations and palpability of the spleen are not generally considered reliable for diagnosis, without microscopical investigation. From Clark's [1] recent and extensive study with West Indian negroes upon the value of palpation of the spleen and examination of thick blood films, he found in the examination of 11,000 adults a parasite rate of 23.5 per cent and a spleen rate in the same persons of only 3.5 per cent. In other words, only 110 of the 2,585 adults whose blood films were positive for malarial parasites had also palpable spleens. If palpation alone had been relied on in this survey, the diagnosis would have been missed in 2,475 of 2,585 positive cases. In children of whom 1,102 were examined, the parasite rate was 41.9 per cent and the spleen rate was only 22.78 per cent; that is, only 175 of the children whose blood films were positive for malaria had palpable spleens. If palpation alone had been employed, the diagnosis would have been missed in 287 of 462 positive cases. Clark's careful investigations demonstrate that as a quantitative method for selecting adult males in need of treatment for malaria, palpation of the spleen is unreliable and that its success is limited even when applied to children.

Observations of this nature and other similar ones referred to would seem conclusively to demonstrate the fallacy of spleen palpation alone in the diagnosis of malaria.

Splenomegaly

One also notes a very great difference in the prevalence of marked splenomegaly on the West Coast of Africa as compared with that which exists in parts of the Amazon basin in Brazil.[2] Malaria widely prevails in both regions, but on the West Coast of Africa advanced splenomegaly is not a striking feature, whereas in the Rio Branco regions it is, and large spleens, to or below the level of the umbilicus, are common.

In connection with this subject it is of interest to note the recent studies of Lambert and Olivera [3] who in seven cases of lethal malaria found only one spleen weighing as much as 820 grams. In three of the cases the spleen weighed only 250 grams or less, while in a number of other cases of subsidiary malaria where death occurred from other causes, the spleen was either not distinctly overweight or was even somewhat less than the normal weight of 150 to 170 grams.

Ziemann,[4] who had a wide experience with malaria on the West Coast of Africa, tends to emphasize the fact that marked splenomegaly is comparatively rare in association with malaria throughout the Cameroons.

Clark [5] found in Central America (the Caribbean area), that while extreme cases of splenic enlargement, 1000 grams or more in weight, were not infrequent in the Latin-American labor class, that they were very rarely encountered in the negro, even in those who had lived for a number of years on the mainland under the same environment as the Latin-Americans.

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[1] Clark, H. C: Amer. Jour. Trop. Med. (1928), VIII, 423.

[2] Strong and Shattuck: Medical Report of Hamilton Rice 7th Exped. to the Amazon (1926), p. 74.

[3] Lambert and Olivera: Porto Rico Review of Public Health and Trop. Med. (1929), IV, 299.

[4] Ziemann: Malaria und Schwarzwasserfieber, Mense's Handbuch der Tropenkrankheiten, Bd. III (1924), pp. 211, 218–287.

[5] Clark: United Fruit Co. Medical Dept. 16th Annual Report (1927), p. 99.

In other parts of Africa, the splenomegaly very frequently follows infection with *Schistosoma*. This fact has been especially emphasized by Ferguson[1] and Day[2] and by Richards[3] and more recently by Bonnin,[4] Schweizer,[5] Coleman,[6] Stiven[7] and Girges.[8]

In Amazonia infection with *Schistosoma* has not been observed. It is important definitely to determine whether all the splenomegaly of Amazonia is a manifestation of malarial infection or whether some of it does not represent a form of splenic anaemia of other origin.

Summarizing the cases of splenomegaly observed during the present Expedition, it is of interest to note that the malaria cases in which parasites occurred in the blood showed a splenic index of 22.4 per cent. However, the index for the consolidated survey, including many in which blood smears were lost or destroyed, was 18.6 per cent. Very large spleens were rare in Liberia. In only 4.7 per cent was the spleen markedly enlarged. This is a very low rate as compared with Amazonia. Table III illustrates the results of special splenic surveys carried on in Liberia. There were eight other cases of splenomegaly observed where malaria or tuberculosis were probably concerned in the enlargement. Of three advanced cases of splenomegaly seen during the present African Expedition, one was observed at Yakusu in the clinic of Dr. Chesterman, in a man aged forty to forty-five, whose general health was apparently fair. The abdomen of this patient was much enlarged and the spleen extended below the umbilicus and across the median line to the right. The liver was not palpable and there was no ascites or general glandular enlargement. The diagnosis made by examination of fresh and stained blood films was lymphatic leukemia. In the second case of marked splenomegaly, which also showed enlargement of the liver with ascites, the ova of *Schistosoma haematobium* were found in the urine, and there were no malarial parasites in the blood (see Schistosomiasis, page 226, Case 202). In the third case observed in a girl aged ten years, the patient complained of cough, but looked healthy, and the mucous membranes were of good color. However, there were râles in the right side of the chest. The spleen was palpable for a distance of about 10 cm. below the costal margin. The blood was negative for malaria. Splenic puncture and cultures did not reveal any parasites or structures suggesting mycotic infection.

We have discussed previously at some length, in the Report of the Amazon Expedition (1926),[9] the etiology of the different forms of tropical splenomegaly. Since the publication of this report and during the year spent upon the present

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[1] Ferguson and Day: Ann. Trop. Med. & Parasit. (1909), III, 379.

[2] Day: Trans. Royal Soc. Trop. Med. and Hyg. (1924), XVIII, 121.

[3] Richards: British Jour. Surg. (1914), I, 418.

[4] Bonnin: Gaz. hebd. Sci. Méd. de Bordeaux (1928), XLIX, 387, 403.

[5] Schweizer: Schweiz. Med. Woch. (1927). LVII, 1017.

[6] Coleman: Trans. Royal Soc. Trop. Med. and Hyg. (1926–1927), XX, 224.

[7] Stiven: London Hosp. Gaz. (1928), XXXI, 225.

[8] Girges: Jour. Trop. Med. and Hyg. (1929), XXXII, 280. *Ibid.* (1930), XXXIII, No. 1, p. 1.

[9] Strong and Shattuck: Medical Report of Hamilton Rice 7th Exped. to Amazon (1926), p. 74.

Expedition in Africa, considerable attention has been directed to the existence of a mycotic form of splenomegaly.

Nanta, Pinoy, and Gruny [1] first reported upon five cases of infectious splenomegaly observed in Algeria, in all of which the spleen was removed. These spleens, they stated, presented characteristic lesions which could be observed with the naked eye, and consisted of nodules one to two millimeters in diameter, of the color of iron rust. These were very hard and adherent to the splenic tissue, from which one was able to separate them only by tearing away the little vessel around which they are formed. Histologically the entire splenic tissue presented remarkable granulomatous transformation with slight sclerosis. The nodules referred to, which are perivascular, were made up of a dense sclerotic growth infiltrated with enormous giant cells and filled with ferruginous pigment. The most characteristic feature histologically was the occurrence of long bands or ribbons five to fifteen microns wide, either straight or slightly waving, sometimes refracting and colorless, sometimes stained like bundles of connective tissue in basophilic degeneration. Cultures from the spleens were sterile, but in the smears, and on section, one encountered two organisms; first a waving spirochaete, larger than the treponema, with loose spirals which are not numerous, and second a strepto-bacillus which was encountered only in the nodules and which formed filaments and cysts absolutely like the myxobacteria.

In the second paper which they presented to the Academy of Sciences of Paris [2] they reported upon a "myxobacterian" splenomegaly and on the "synbacterium" isolated from cases of splenomegaly. They pointed out that the spirochaetes previously mentioned are not constant in the spleens, but the parasite *Synbacterium splenomegaliae* forms cysts and bands with clavae and spines analogous to those found by Magrou in experimental staphylococcic botryomycosis. They were thought to resemble somewhat a coccus or an encapsulated diplococcus which upon inoculation into the guinea pig killed the animal and produced congestion of the spleen and adrenals in which were found the encysted germs and sometimes long filamentous forms.

In the third paper published by Pinoy and Nanta [3] in 1927, upon the common mycosis of the spleen in Algeria, they record that the pseudocysts found in cases of splenomegaly (in which the nodules previously described by Gamna are present) are either forms of fructification or perithecial appendages of the fungus, *Sterigmatocystis nidulans*. They regard these cases of splenomegaly as infections with mycetozoa. They further believe that the fungus may penetrate through the skin or through the intestine, and in doing so secondary infections of various bacteria might result and modify the clinical aspect of the conditions. They suggest the possibility of Egyptian splenomegaly having the same mycotic etiology and insist upon the prevalence in Algeria of such a mycosis of the spleen.

Pinoy [4] later proposed for the fungus isolated from the spleen the creation

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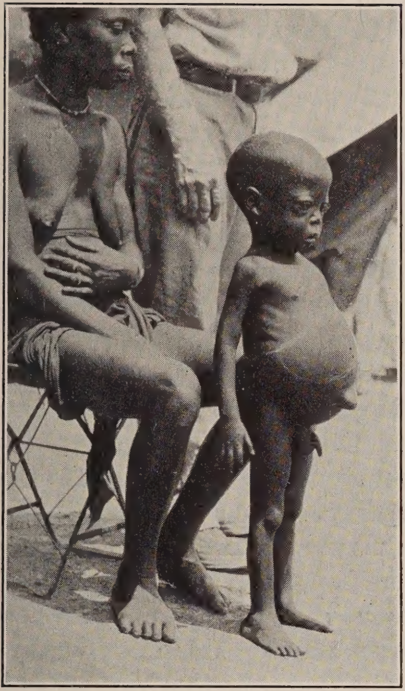
[1] Nanta, Pinoy, and Gruny: Comptes Rendus Soc. Biol. (1926), XCIV, 635.

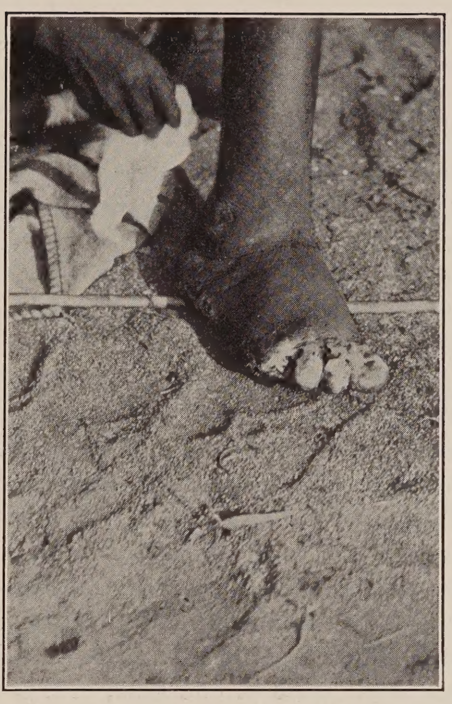
[2] Pinoy, E: C. R. Acad. des Sciences (1926), CLXXXII, 1429.

[3] Pinoy and Nanta: C. R. Acad. des Sciences (1927), CLXXXIV, 347.

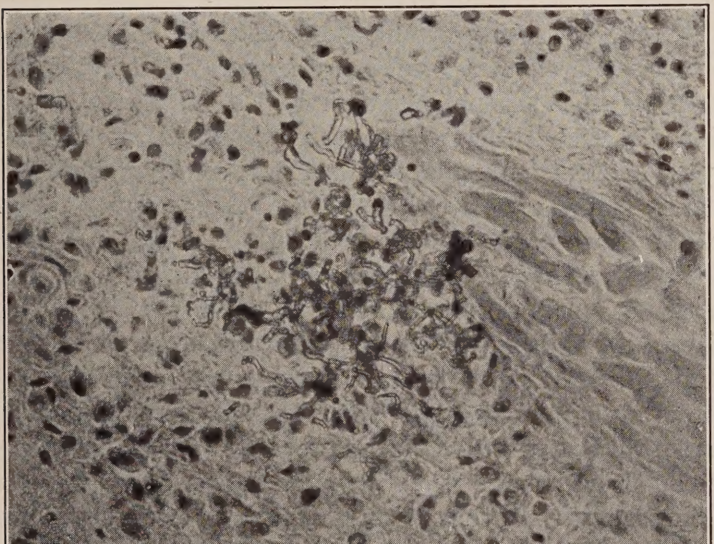
[4] Pinoy: Congress for Adv. Science in Constantine, cited in Supple., Mem. Inst. Oswaldo Cruz (Aug. 31, 1928), No. 1, p. 17.



No. 167. — Splenomegaly, Case 202



No. 168. — Elephantiasis and papillomatous formation



No. 169. — Mycotic infection of spleen of hyena

of a new species *Aspergillus nantae* which could be distinguished from *Aspergillus nidulans* among other characters by the absence of perithecia in the cultures.

Emile-Weil, Gregoire, and Flandrin,[1] in 1927, in a way confirmed these observations and have reported upon seven cases of primary splenomegaly produced by mycotic infestation. They point out that the condition, however, should not be termed "Algerian," because it is equally common in France. The process is usually a chronic one. While the clinical diagnosis is frequently difficult, the pathological diagnosis is not so on account of the presence of the characteristic yellowish-brown nodules, about the size of a millet seed and of the color of iron rust, which permit a diagnosis being made by the naked eye.

Histologically these nodules are said to be absolutely characteristic and are surrounded by a congested zone, while the interior is formed of one or more vessels sclerosed in their outer coats. Around the vessels there are fibroblasts and filaments of abnormal connective tissue; at the periphery many plasma cells and true giant cells, sometimes containing fragments of mycelium or spores. The whole nodule is stuffed with mycelian filaments recognizable by their segmentary structure, and often by their terminal swelling. In other cases, large encapsulated spores were found. In two cases cultures of the fungus were obtained on Sabourraud's medium or on "gelose ascite." The growth appeared after eight days in one case, and twenty in the other, in the form of whitish colonies which enlarged and became dark green. They point out that while Pinoy and Nanta [2] earlier identified the fungus as *Sterigmatocystis nidulans*, Emile-Weil and his associates are inclined to believe it is an *Aspergillus*.

In later papers,[3] they refer to the causation of Banti's disease by this fungus, and state that it seemed to be the same in all seven cases studied. Although it was regarded as an *Aspergillus*, the species was not at first identified, but it was pointed out it was not identical with *Aspergillus fumigatus*. No bacterial infections of the spleen were observed in the sections or in cultures. In a subsequent publication the fungus was identified as *A. amstelodami*.[4]

In June 1927, Nanta [5] reported upon the study of twenty spleens which had been extirpated; three for injury, one for hydated cyst, one for malarial hypertrophy and the remaining fifteen for splenic anaemia. These fifteen could be divided into two groups, (1) in which only bacteria were found and no nodular lesions similar to those described by Gamna in different diseases of the spleen, and (2) in which in addition to bacteria a fungus and nodular lesions were present. He points out that the frequent occurrence of mycotic and bacterial infections makes it difficult to decide the part played by each in the development of the lesions and whether the mycotic infection is primary or secondary.

Goinard [6] in his review of the entire subject in his book upon Algerian splenomegaly includes the study of fifteen cases. In twelve mycotic tubercles of the spleen were found. These were the cases studied by Pinoy and Nanta and constitute mycetomas of the spleen. In three cases there were no mycotic tubercles, but direct examination for cultures showed forms of bacteria. These were regarded as bacterial forms of splenomegaly. He points out that the question of the pathogenicity of these various organisms cannot yet be definitely determined. In three cases in which the cultures of the fungus could be identified, it was recorded as *Sterigmatocystis nidulans*, which has already been accepted as one of the pathogenic causes of Madura foot. With reference to the bacteria isolated in the different cases, a streptobacillus was found which was extremely virulent for laboratory animals and reproduced in them some of the signs of splenomegaly in man. In other cases there was found a spirillum, a pseud-odiphtheroid, a streptococcus and the typhoid bacillus. He points out that it is possible that some of these organisms were pathogenic agents and others of accidental occurrence in a spleen already diseased. Clinically, there was nothing especially characteristic of the different types.

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[1] Emile-Weil, Gregoire, and Flandrin: Bull. et Mém. Soc. méd. des Hôpit. de Paris (1927), No. 17. p. 713.

[2] Pinoy and Nanta: Académie des Sciences (1927), CLXXXIV, 347.

[3] Gregoire, Emile-Weil and Flandrin: Etiology of Banti's Disease. Bull. et Mém. Soc. Nat. de Chirurg. (1927), LIII, 734; Emile-Weil: Ann. d'Anat. Path. et d'Anatomie Normale (1927), IV, 573.

[4] Emile-Weil, Chevallier and Flandrin: Bull. et Mém. Soc. Méd. Hôpit. de Paris (1927), LI, 1425.

[5] Nanta, A: Ann. d'Anat. Path. et Anatomie Normale (1927), IV, 573.

[6] Goinard: Sur Certaines Splenomégalies Algeriennes. Paris, Lib. Louis Annette (1927).

Askanazy and Schweizer [1] studied five cases of Egyptian splenomegaly in which the spleens had been extirpated. In one of the fatal cases there were pulmonary complications and in the others lesions of the liver, consisting of infiltration and the formation of pseudotubercular nodules containing the ova of *Schistosoma mansoni*. In three of the cases the spleens contained fibrous granules containing fungus hyphae which were frequently enclosed in giant cells and from which swollen and segmented hyphae extended into the surrounding tissue. In no case were other parasitic organisms encountered in the spleens. Schweizer [2] in a second paper concludes that some cases of Egyptian splenomegaly must be placed in this new group of "Splenomegalia mycotica."

Petridis [3] has also studied recently six cases of Egyptian splenomegaly in Alexandria. The spleens which were removed were examined by Askanazy of Geneva, who drew his attention to the fibro-siderotic or sidero-mycotic foci. Petridis found in certain cases that the liver contained *Bilharzia* ova. He points out, however, that Egyptian splenomegaly has a dual etiology, one bilharzial and the other mycotic. Askanazy, however, believes that the etiological rôle of the fungus should be regarded as still uncertain until the disease has been produced experimentally.

A number of other authors, Sabrazes and Muratet, Bécart, Coyon, Willemin Cloy and Brun, Arsen Prodanos,[4] Popper, Raileanu [5] and Zorini [6] have also published papers in support of the idea of the existence of a mycotic form of splenomegaly. Other observers, however, have recently contested this claim.

Oberling [7] in connection with the subject, reinvestigated his collection of over two hundred spleens obtained by operation or autopsy. Twenty-four of them were found to have mycotic infection and contain the Gandy-Gamna nodules shown to be of mycotic origin by Nanta and others. In ten of these cases, the mycelium was calcified and degenerate and in the remaining fourteen the mycelium was well preserved. In all of the four cases of Banti's disease, mycotic nodules were found. Such nodules were also found in different forms of cirrhosis of the spleen, as well as in Algerian splenomegaly. In view of the fact that the mycotic infection was encountered in a great variety of pathological conditions, he concludes that it is probably only secondary in nature and occurs in a spleen which has already been injured in some manner. He thinks that the mycotic infection may follow one of two courses, either that the mycosis develops for a time and then retrogresses and the lesions undergo cicatrization or, in other cases, the mycosis develops rapidly and infiltrates the spleen with mycotic nodules.

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[1] Askanazy & Schweizer: Sch. Medizinische Woch. (1927), LVII, 777.

[2] Schweizer: *Ibid.*, p. 1017.

[3] Petridis, P.: Presse Méd. (1928), XXXVI, 546.

[4] Prodanos: Cited by Olympio de Fonseca and A. E. de Area Leao. Inst. Oswaldo Cruz. Sup. das Memorias. No. 1. Aug., 1928.

[5] Popper and Raileanu: Bull. et Mém. Soc. Méd. Hôpit. de Bucarest (1928), X, 48.

[6] Zorini, A.: "Splenogranulomatosi siderotica" Bologna (1928), L. Cappelli.

[7] Oberling: Presse Méd. (1928), XXXVI, 2.

Gamna,[1] however, has deplored the manner in which certain authorities, in conformity with the work of Nanta and Pinoy, have accepted the presence of Gamna nodules as being diagnostic of splenic mycosis and have regarded these nodules as mycotic tubercules. He points out that he has described these nodules in many different diseases of the spleen and states that there is as yet no decisive evidence that they are specifically mycotic. He also believes that it has not been proved that the filaments in the spleens examined are really of mycelian origin and that in only three or four cases have cultures of a fungus been isolated, and further, that the pathogenicity of this fungus has not yet been demonstrated.

Langeron [2] also, after a review of the literature upon the subject and from the study of certain cultures isolated from cases of splenic mycosis, as well as of a number of the spleens which were considered to be infected, concludes that there is no justification for considering that there is a mycotic form of splenomegaly. He believes that the fungi which have been obtained in cultures from such spleens are accidental contaminations of non-pathogenic forms and that the filaments and conidial structures described as mycelial in character in the spleens constitute pathological changes in fibrin and collagen in haemorrhagic areas.

In still later papers, however, Nanta, Emile-Weil, and Pinoy [3] firmly maintain the existence of this mycotic form of splenomegaly. Nanta and Pinoy point out as evidence of the pathogenesis of the organism that intravenous injections of a culture of *Aspergillus fumigatus* in a rabbit proved fatal after eight days and produced lesions comparable to those of human splenomegaly, though much more acute in character.

The question has been studied more recently in Brazil by Fonseca and Leao [4] who have examined the specimens of splenomegaly in the Institute Oswaldo Cruz at Rio de Janeiro in some of which siderotic nodular lesions have been observed. They conclude from the study of this material that the aspect of certain structures and filamentous elements described may at first sight impress one as resembling that of mycelial elements and of mycetoma grains. They emphasize, however, that a more minute observation of the spleen sections from the Brazilian cases of splenomegaly which they had the opportunity of examining did not permit them to verify the presence of a single element which unquestionably might be attributed to fungi. On the other hand, all the formations found showed transitions to such other elements which clearly could not be considered mycelial and in fact were connected with changes of tissues which are observed in many different morbid conditions. They agree with Gamna and Langeron in the interpretation of these supposed mycotic appearances.

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[1] Gamna, C.: Presse Méd. (1928), XXXVI, 357.

[2] Langeron, M.: Ann. Parasit. Humaine et Comparée (1928), VI, 211; Reprint from La Presse Médicale (May 9, 1928), No. 37.

[3] Nanta, Emile-Weil and Pinoy: Presse Méd. (1928), XXXVI, 579.

[4] da Fonseca and de Area Leao: Inst. Oswaldo Cruz. Sup. das Memorias, No. 1 (Aug. 31, 1928).

Jaffe and Hill[1] have also recently reported upon the subject of splenic mycosis. They however were able to confirm the observations of Nanta, Weil and Askanazy that the siderotic nodules of the spleen contain mycelia and fructification organs of an *Aspergillus*. Such structures were found in two cases of juvenile splenomegalic anaemia, three cases of sickle cell anaemia, and one case of tuberculosis of the spleen. It seemed to them that different types of *Aspergillus* can produce similar changes in the spleen. They think that the occurrence of the fungus in the spleen under different pathological conditions does not favor the theory regarding the existence of a disease entity caused by a fungus, and they considered that certain changes apparently rendered the spleen suitable to an infection with *Aspergillus*. These changes consist of the enlargement of the pulp with blood, and in intratrabecular haemorrhages which were due either to disturbances in the portal circulation or to alterations of the blood. They believed the reactions of the body against the fungus were the formation of foreign body giant cells and proliferation of the connective tissue. The mycelia and fructification organs absorb iron and calcium salts and are finally buried in sclerosed connective tissue. The last may also become calcified. They found these forms of *Aspergillus* in enlarged as well as in atrophic spleens and therefore state that the term, splenic mycosis, as suggested by Nanta is preferable to mycotic splenomegaly. In the one case in which Jaffe and Hill cultivated a fungus the spleen weighed only 425 grams.

It seems obvious that exceedingly great care must be exercised in the preparation of cultures from organs where mycotic infection is suspected. Various fungi often present in contaminated air and dust are very likely to infect the culture medium and the development of a few colonies of fungi in one's media is sometimes very perplexing with reference to their origin. In regard to the culture obtained in their one case, Jaffe and Hill merely state: "From this spleen an *Aspergillus* was obtained. It grew on Sabourraud medium in two weeks and resembled an *Aspergillus fumigatus*."

MacCarty[2] in the study of 320 spleens from cases of splenomegaly made in the United States, does not refer to mycotic splenomegaly.

Finally, McNee[3] has made a most careful study of the etiology, pathology, and frequency of the forms of splenomegaly occurring in Great Britain. He illustrates both the macroscopic and microscopic appearance of the typical fibrotic nodules with central arterioles in one type of splenomegaly. He points out that he has confirmed the presence of abundant calcium in the nodules in addition to iron, and believes that what has been described by others as "fructification organs" of the fungus are simply small round, often double-contoured masses of calcium exactly similar to those often seen histologically in chronic inflammatory or fibrotic lesions elsewhere.

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[1] Jaffe & Hill: Arch. Path. (1928), VI, 196.

[2] MacCarty: Arch. Int. Med. (1928), XLI, 536.

[3] McNee: Glasgow Med. Jour. (1929), CXI, pp. 65, 193, 288.

He also refers especially to the peculiar light green or almost colorless crystals which are seen in the center of the nodules and which were first observed by Gandy. These vary greatly in width, and both large and small crystals are joined together in a way resembling the segments of bamboo canes. They are often incrusted with pigment giving an intense haemosiderin reaction and they remain quite unstained after the application of ferrocyanide of potassium and hydrochloric acid to the sections. He says it would certainly not be difficult to mistake the smaller and more slender crystals, placed together as they often are in an apparently branched formation, for a fungus. The exact chemical composition of these crystals is not quite certain, but the view is favored that they are composed of phosphate of iron. The fine filaments which form a branching and felted network throughout the nodules and which are always colored an intense blue in sections stained for iron, are in his opinion, undoubtedly degenerated fibers, both of fibrous and elastic connective tissue and cannot possibly be a streptothrix or a fungus.

With reference to the question of the presence of a streptothrix or *Aspergillus*-like organism in the nodules, he is of the opinion that all the evidence based on histological examination and on methods of staining mycelium must be discounted, since the degenerate elastic and other fibers and branching crystals and the calcification are such obvious sources of error. He has made cultures from eleven of his cases of splenomegaly chiefly on Sabourraud's medium using as a rule actual nodules torn out from the spleen, but except for a few obvious contaminations, no results have been obtained. A streptothrix actually was grown in culture from one spleen in the collection but from a case placed provisionally in his Group IV of the splenomegalies in which neither nodules nor perivascular haemorrhage were found. A culture of this organism produced no important changes when injected into the splenic vein of a cat. For the present, therefore, McNee is compelled as a result of his own observations to leave the question of the mycotic infection in this group of splenomegaly entirely *sub judice.*

Through the kindness of Professor Brumpt, Director of the Laboratory of Parasitology of Paris, we were furnished with a number of sections of the spleen from one of these cases which was thought might be mycotic splenomegaly and was so reported by Dr. Emile-Weil. These sections, since our return to the United States, have been stained with Giemsa's solution, methylene blue and eosin and hematoxylin and eosin and subsequently studied. However, we have been unable to detect the presence of mycotic elements in these sections of the spleen.[1]

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[1] Professor Brumpt in a recent letter to the author has informed him that these sections came from the case "Lenoire" of Dr. Emile-Weil. Professor Langeron (Ann. Parasit. Humaine et Comparée [1928], VI, 211) has also reported upon the negative examination of this case as regards the presence of fungi.

Also, we have not encountered in Africa any cases of splenomegaly which we could demonstrate were of mycotic origin during life.

In one hyena of the eastern Belgian Congo which was shot at night and upon which it was not practicable to perform the necropsy until the following morning, stained film preparations and sections both showed a mycotic infection of the spleen (No. 169), both the spores and short mycelial threads being easily detected in different parts of the spleen. In another instance of an elephant, shot at about sunset, it was also not practicable to perform the necropsy until the following morning. In the study of the sections of the intestine and spleen of this animal made after our return to this country, there was also found to be an infection of the tissues by a fungus. In the intestine the fungus was apparently present before death and subsequently invaded the intestinal coats and spleen. It is presumed that in both these instances, the invasion of the fungus was postmortem because there is no cellular reaction in the tissues about the fungi. The opportunities for postmortem and secondary invasion of various lesions in Africa by fungi, should not be lost sight of. It seems possible that under some conditions, postmortem infection of a human spleen with fungi might also occur. We have already referred (page 221) to the care that should be exercised in preparing cultures with reference to the demonstration of mycotic infection.

Yellow Fever

The situation with reference to the occurrence of yellow fever in Liberia is of interest. Shortly before our visit to Monrovia, Dr. G. Bouet had reported upon the recent occurrences of six cases of this disease, two of which were fatal.[1] Dr. Bouet had previously had knowledge regarding yellow fever in earlier years and from his description of the symptoms of the two fatal cases in which black vomit and albuminuria were present, the diagnosis of yellow fever would appear to be consistent. No cases of yellow fever occurred while we were in the country, and no cases were found by Dr. A. W. Sellards of our Department of Tropical Medicine who went to Monrovia to investigate the yellow fever situation the year after our return.

However, in February of the present year (1929), according to the statistics of the Health Section of the League of Nations and information furnished us through the courtesy of Mr. Harvey S. Firestone, Jr., there were, in Monrovia, two cases of yellow fever on February 26; one case on March 5; three cases on April 3; three cases on April 9; and two cases about June 30. These are apparently the only cases of yellow fever that have been reported in West Africa during the present year. According to the information we have received, six of these Liberian cases were fatal; the last two fatalities were in American citizens, — Mr. James L. Sibley and the American Minister, Mr. Francis. It is unfortunate that no necropsies were performed upon the fatal cases.

The origin of these sporadic cases of yellow fever in Monrovia is somewhat obscure. There is little or no justification for supposing that the infection on all these different occasions has been imported. Perhaps the infection is kept alive in Liberia during the long intervals between fatal cases, in children and adults who have a relative immunity and who undergo very mild attacks of the infection and recover. Certainly Monrovia has no high death rate from any single disease, and there has been no large epidemic of any infectious disease for a number of years.

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[1] Bouet: Bull. Soc. Path. Exot. (1925), XVIII, 746.

An outbreak of yellow fever also occurred on the west coast of Africa in Senegal and in Accra and Lagos, during the year 1927. Cases also occurred in Dahomey and in the Ivory Coast. Lasnet[1] reported six cases among the Europeans, three in Dahomey of which one was fatal, and three in the Ivory Coast, all fatal. Lasnet[2] and Cazanove[3] have described the epidemic of yellow fever in Senegal in 1927. The total number of cases from May to the thirty-first of December, for the entire colony, was 190, of which 135 died, a mortality of 70.89 per cent. Eighty-two of the cases, with fifty-eight deaths occurred in Dakar. Selwyn-Clarke[4] reports that in Accra the epidemic in the colony in 1927 affected the African population rather more than the European, as there were eighty-eight cases with twenty-five deaths in the former and fourteen cases with ten deaths in the latter. In addition there were five cases of Syrians with five deaths. Mouchet[5] has reported upon the first outbreak of the disease recorded from the Congo which occurred in Matadi and Boma in December, 1927 and January, 1928. At Boma there were only three cases, two imported and one local and no natives were affected. At Matadi there were nineteen cases among Europeans of which eight recovered and eleven died. Twenty natives became infected, of whom five recovered and fifteen died. Sicé and Vaucel[6] have found that *Aëdes aegypti* (*Stegomyia fasciata*) is abundant at Brazzaville, one hundred and fifty-five miles further up the Congo than Matadi. Apparently this mosquito may be found when looked for in almost any part of the Congo. It has been shown to exist at Stanleyville by Dr. Mouchet, at Albertville on Lake Tanganyika (Dr. Schwetz), and at Elisabethville in Katanga (Dr. Schwetz).

The west coast of Africa has long played an important part in the history of yellow fever. Reference has already been made to the suggestion that the mosquito, *Aëdes aegypti*, which commonly transmits the infection was originally imported into America from the West African coast. As yellow fever still occurs from time to time along this coast, it is of some interest to refer here to the recent advances made in our knowledge of this disease.

After the isolation of *Leptospira icterohaemorrhagiae* by Inado and Ito in hemorrhagic jaundice, and of *Leptospira icteroides* by Noguchi from cases of yellow fever, we had frequent opportunity to compare the micro-organisms.

For several years in our laboratories we were unable to distinguish any differences, either in morphology or pathogenic action in animals, between *Leptospira icteroides* and *Leptospira icterohaemorrhagiae*, and we asked the question, — Is the difference between the two merely one of virulence, and may there not be another organism concerned in the etiology of yellow fever?

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[1] Lasnet: Bull. Office Intern. d'Hyg. Publique (1929), XXI, 49.

[2] Lasnet: *Ibid.*, p. 54.

[3] Cazanove: Bull. Soc. Path. Exot. (1929), XXII, 260.

[4] Selwyn-Clarke: Gold Coast Report of Med. and San. Dept. for the year April 1927 to March 1928, XXVII, 121; also Brit. Med. Jour. (1930), p. 298.

[5] Mouchet: Ann. Soc. Belge de Méd. Trop. (1928), VIII, 219.

[6] Sicé and Vaucel: Bull. Soc. Path. Exot. (1928), XXI, 768.

Theiler and Sellards [1] continued the work and were unable to differentiate the two organisms by Pfeiffer's reaction, and found guinea pigs immunized to one were also immune to the other, indicating serological identity of the two organisms. Schuffner and Mochtar [2] later confirmed this work.

Sellards [3] then found in the study of the blood serum of eleven patients, taken three and a half months after recovery from yellow fever, that Pfeiffer's reaction with both *L. icteroides* and *L. icterohaemorrhagiae* was negative, while with guinea pigs immunized with these organisms, it was always positive. Sellards and Theiler further showed that the blood serum of five cases of leptospiral jaundice all showed a positive Pfeiffer's reaction for considerable periods after recovery.

Sellards and Gay [4] then showed that *L. icterohaemorrhagiae* and *L. icteroides* behave in a similar manner in the mosquito, *Aëdes aegypti*. Neither strain was transmitted from guinea pig to guinea pig nor to human volunteers by the bite of this mosquito. After the ingestion of either strain by the mosquito, the numbers of *Leptospira* diminished rapidly in the first few days, then more slowly for several weeks, and eventually disappeared completely.

It will be remembered that *Aëdes aegypti* had previously been shown to transmit yellow fever for at least fifty-nine days after having bitten an infected patient.

Important discoveries with reference to yellow fever were also made in West Africa during 1927–1928 by Stokes, Bauer and Hudson, Klotz and Simpson, all working in the Rockefeller Institute, in Lagos or in Accra, and by Sellards of the Department of Tropical Medicine of Harvard University, and Mathis and Laigret of the French Medical Service at Dakar. Klotz and Simpson [5] showed that from a pathological standpoint there is no fundamental difference between yellow fever as it occurs in Africa and America, the same pathological lesions being noted in both. *L. icteroides* was not found in the African cases. The late Adrian Stokes then showed that yellow fever in Africa could be transmitted to the monkey (*Macacus rhesus*), both by the inoculation of blood from human cases of the disease and by the bites of infected *Aëdes aegypti* that had been previously fed upon human cases of yellow fever. Stokes, Bauer, and Hudson [6] confirmed and extended this and other work by showing that mosquitoes once infected with the yellow fever virus remained infective for the rest of their lives, exceeding three months in some instances. Attempts to cultivate *Leptospira* or to find them in the tissues from animals infected with yellow fever virus, failed. Finally, Mathis, Sellards, and Laigret [7] also have shown that yellow fever may be transmitted to the *M. rhesus* monkey by the inoculation of blood from human cases and by the bites of infected *A. aegypti.* Sellards[1] furthermore has demonstrated that the virus of yellow fever may be transported in the frozen liver of infected monkeys. He was able in this way to transmit the virus from Africa to England, Europe and the United States, and has thus permitted of a more extended and careful study of the nature of the infectious agent in this disease.

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[1] Theiler and Sellards: Amer. Jour. Trop. Med. (1927), VII, 369.

[2] Schuffner and Mochtar: Arch. f. Schiffs- und Tropen-Hyg. (1927), XXXI, 149.

[3] Sellards: Amer. Jour. Trop. Med. (1927), VII, 71.

[4] Sellards and Gay: Ann. Trop. Med. and Parasitology (1927), XXI, 321.

[5] Klotz and Simpson: Amer. Jour. Trop. Med. (1927), VII, 271.

[6] Stokes, Bauer, and Hudson: Amer. Jour. Trop. Med. (1928), VIII, 103; *loc. cit.*, p. 261; *loc. cit.*, p. 371.

[7] Mathis, Sellards, and Laigret: Comptes rendus séances Acad. d. Sciences (1928), CLXXXVI, 604, and see Trop. Dis. Bull. (1929), XXVI, 647; Conférence Africaine de la Fièvre Jaune (1928).

Theiler and Sellards[2] have shown by immunological experiments also that the yellow fever in West Africa and that which occurs in South America are apparently identical, and Hudson, Bauer, and Philip[3] still more recently confirmed these observations. A review of the recent work carried on in Africa by the International Health Board upon yellow fever is given in the Annual Report of the Rockefeller Foundation for 1928.

It was in connection with the investigations upon yellow fever carried out in Lagos, Nigeria, and Accra on the Gold Coast that Doctors Adrian Stokes, Hideyo Noguchi, and W. A. Young became infected with the yellow fever virus and succumbed to the disease. Dr. A. Maurice Wakeman, also engaged in this work, shortly afterwards died in Africa. In their tragic deaths, which have been such a shock to us, and which occurred while their investigations upon yellow fever were being pursued, science has suffered a great loss.

The species of *Aëdes*, in addition to *A. aegypti*, found in Liberia and along the West African coast, and capable of transmitting yellow fever are referred to in Chapter XIII, page 192.

Pichat[4] and Cazanove[5] have recently emphasized the fact that in urine analyses the presence of albumin and peptone furnishes a useful aid to the diagnosis of yellow fever during the course of the disease. It may be mentioned that after recovery the demonstration of the presence of immune bodies in the serum of the convalescent individual, by the inoculation of monkeys with his serum and subsequent attempts to infect the animals with the yellow fever virus, is sometimes of considerable value in diagnosis. It appears that the blood serum of individuals who have recovered from yellow fever reveals the presence of such immune bodies for long periods of time.

SCHISTOSOMIASIS

Schistosomiasis is not uncommon in Liberia, both among the tribes in the interior and in the inhabitants nearer the coast. As has been noted, the most advanced case of splenomegaly observed was in a child (Case 202, No. 167), in which the ova of *Schistosoma haematobium* were found in the urine. The ova are generally found in fair numbers, but the infections are usually not exceedingly severe. In Liberia, as is customary, the terminal-spined ova of *S. haematobium* were found in the urine in cases with genito-urinary disturbances, and the lateral-spined ova of *S. mansoni* in the faeces, with disturbances of the rectal mucosa and intestine. In only one case was *S. haematobium* found in the faeces and in only one was *S. mansoni* found in the urine. However, in parts of the central Belgian Congo about Stanleyville the ova found in the faeces in several intestinal cases of infection possessed a terminal spine.

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[1] Sellards and Hindle: Brit. Med. Jour., April 28, 1928.

[2] Theiler and Sellards: Ann. Trop. Med. and Parasit. (1928), XXII, 449.

[3] Hudson, Bauer and Philip: Amer. Jour Trop. Med. (1929), IX, 1.

[4] Pichat: Bull. Acad. Méd. (1929) CI, 445.

[5] Cazanove: Bull. Soc. Path. Exot. (1929), XXII, 447.

Chesterman [1] has pointed out that at Yakusu, near Stanleyville, intestinal bilharziasis is the only form of the disease which occurs and that the cases show terminal-spined eggs somewhat more elongated than those typical of *S. haematobium*. He also pointed out that the local intermediary host is very like, if not identical with, *Bullinus contortus*.[2] (See also No. 174.)

Blacklock [3] examined the urine of 668 cases in Sierra Leone for *S. haematobium* infection and found ova in 215 of the cases. Examination of the faeces proved negative with one exception, in a woman, where the terminal-spined ova of *S. haematobium* were found.

Leiper [4] in commenting upon this rare occurrence of the ova of *S. haematobium* in the faeces (which experience corresponded with our own in Liberia), says that in Egypt the eggs are fairly common in the faeces. Leger and Bédier [5] examined 127 natives at Dakar and found that 6.3 per cent of them passed ova of *S. haematobium* in the urine. However, no eggs were found in the faeces of any of these cases.

On the other hand, Nessman and Trensz [6] have recorded three cases of rectal infection with *S. haematobium* in Gabon, French West Africa, and refer to the absence of indications of vesical implication. They believe that such cases are more frequent in this region.

Khalil [7] in other parts of Africa points out that double infection of the urinary and intestinal tracts with the species of *Schistosoma*, *S. haematobium* and *S. mansoni*, is by no means rare. Of 7,090 individuals who were examined, 56 had *S. mansoni* eggs in the urine and of these 48 had a urinary infection with both parasites, while eight had *S. mansoni* alone. Fairbairn [8] and Coleman [9] have also reported double infection with *S. haematobium* and *S. mansoni* in cases of vesical bilharziasis. Leger and Raynal [10] have recently studied instances of aberrant localization of *Schistosoma* ova and find them difficult to explain. Two hypotheses have been suggested by Leger, one to the effect that we may be dealing with a new form of bilharziasis and a second based on the assumption that a special intermediary host such as a particular gastropod in certain regions might be capable of modifying the tropism of the schistosomes. The aberrant localizations of the ova of the schistosomes appear to be encountered exclusively on the continent of Africa, particularly in certain places in Central Africa.

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[1] Chesterman: Ann. Soc. Belge de Méd. Trop., Brux. (1923), III, 73.

[2] Bequaert, however, has identified these specimens of this snail as *Physopsis africana*. (Bull. Amer. Museum Natural History [1927], LIII, 145).

[3] Blacklock: Trans. Soc. Trop. Med. and Hyg. (1925), XVIII, 406.

[4] Leiper: *Ibid.*, 420.

[5] Leger and Bédier: Bull. Soc. Path. Exot. (1923), XVI, 276.

[6] Nessman and Trensz: Ann. Parasit. Humaine et Comparée (1928), VI, 182.

[7] Khalil: Brit. Med. Jour. (1928), p. 546.

[8] Fairbairn: Brit. Med. Jour. (1928), p. 52.

[9] Coleman: *Ibid.*, p. 177.

[10] Leger and Raynal: Corr. from Paris, Jour. Amer. Med. Assoc. (1929), XCIII, 1157.

There are apparently three authentic cases of infection with the terminal-spined elongated ova of *S. spindalis* in man, whose most usual host is *Bos bubalus*. The first of these was recorded by Cawston[1] in 1925 and two others by Porter[2] in 1926 in South Africa. Price[3] points out that the egg described by Chesterman (1923) may also be that of *S. spindalis*. The terminal-spined ova found in the faeces of our cases, measured not more than about 165μ in length, and they correspond more generally with the ova of *S. haematobium*, rather than with those of *S. spindalis*. Since our return to the United States Sandground has remeasured a number of these ova from several of our cases and has found that the measurements vary between 162–169μ in length and from 54–64μ in width. They are thus only very slightly longer than the measurements given by Price for *Schistosoma haematobium* eggs (120–160μ in length by 40–60μ in width), and are evidently much shorter than the ova of *S. spindalis*. Porter gives the measurements of the ova of *S. spindalis*, which she obtained from the urine of man, as 163–258μ long by 46.4–70μ wide. The ova of *Schistosoma bovis* measure, according to Price, 160–180μ long by 50–60μ wide. They, however, have a more blunt and shorter spine than *S. haematobium*.

Cawston[4] reports that at least four distinct types of *Schistosoma* ova occur in the urine of patients in Natal. Under the subject of "The identity of the Rarer *Schistosomes* in Man and Other Intermediate Hosts" he illustrates seven different ova. These are *S. bomfordi*, *S. indicum*, *S. bovis* and *S. spindalis*, in addition to the three common ones, *S. haematobium*, *S. mansoni* and *S. japonicum*.

Price[5] does not include man as a host for *S. indicum* and questions man as a host for *S. bovis*.

Walkiers[6] during the course of a large series of faecal examinations made at Faradje, discovered schistosome eggs with smooth shell and without spine in five cases with bloody diarrhoea. Many of the eggs contained active miracidia. He believed that the eggs are those of a new species of *Schistosoma*, for which the name *S. faradjei* was proposed. In his discussion of this paper, Rodhain called attention to the fact that eggs with a similar appearance and without spine have been reported from Egypt and the Sudan.

We did not encounter ova of this nature in the faeces of the cases we studied either in Liberia or elsewhere in Central Africa.

Obviously there is need for further investigation regarding the identity of these different schistosomes which are reported to infect man in Africa.

In connection with finding only terminal-spined ova in the faeces, the recent observations of Brumpt[7] are of considerable interest. He has shown that the hedgehog can be very readily infected with *S. haematobium* under experimental conditions. He points out that while in human cases the infection with this parasite is usually vesical, in the three experimental infections of the hedgehog that he carried out, although there was a generalized invasion of the bowel wall, and eggs were present also in the liver and pancreas, the bladder was not affected.

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[1] Cawston: Jour. Trop. Med. and Hyg. (1925), XXVIII, 406.

[2] Porter: S. African Jour. Sci., Johannesburg (1926), XXIII, 661.

[3] Price: Proceed. U. S. Nat. Museum. No. 2789 (1929), LXXV, Art. 18, p. 139.

[4] Cawston: Ann. Trop. Med. and Parasit. (1925), XIX, 215.

[5] Price: *Loc. cit.*

[6] Walkiers: Ann. Soc. Belge de Méd. Trop. (1928), VIII, 21.

[7] Brumpt: Ann. Parasit. Humaine et Comparée (1928), VI, 440.

It seems not improbable that almost any single organ of the body may sometimes be invaded with *S. haematobium;* exactly why there is this great preponderance of intestinal infection and so little vesical infection near Leopoldville is not entirely clear. Obviously a more complete study may reveal a greater number of cases of vesical infection.

Brumpt[1] recently suggested that not only the hedgehog but perhaps the monkey might serve as a natural reservoir of *Schistosoma haematobium.* This opinion has recently received support from Cameron[2] who, on a recent visit to St. Kitts in the West Indies found that the monkeys there of African origin are naturally infected with *Schistosoma mansoni.* Hence they may obviously serve in spreading infection. In this connection we may state that *Schistosoma* ova were not found in the intestines of the monkeys we examined in Africa. A new species of trematode, however, was found in a species of *Colobus* monkey shot in the Ituri Forest in the Belgian Congo. This species has been named *Dicrocoelium colobusicola* Sandground, and is described on page 463.

Some attention was necessarily paid to the sterilization by chlorination and other chemical means and by boiling of the drinking water used by members of the Expedition since this evidently was important from the standpoint of preventing infection.

From the information available, it seemed questionable whether chlorine employed in the usual amounts for sterilizing drinking water would destroy the cercariae of *Schistosoma.* In this connection the recent studies of Blackmore,[3] who tested chloramine as a method of purifying Bilharzia-infected waters, are of value. He collected *Planorbis boissyi* which discharged cercariae morphologically resembling those of *Schistosoma.* The exposure of these to the dilution of one part per million of free chlorine caused immediately increased activity, followed by complete cessation of movement in about five minutes. All the cercariae were apparently dead within twenty minutes, loss of motility being taken as evidence of death. In another experiment the cercariae were dead in less than five minutes, being destroyed by less than the concentration of chlorine usually necessary for the disinfection of water. He found the cercariae extremely susceptible to the action of free chlorine.

There is obviously need for a safer drug than tartar emetic in the treatment of schistosomiasis, as the studies of Khalil[4] emphasize. Khalil has collected and analyzed symptoms appearing after the injection of the antimony compounds. These comprise cough, fainting, rise of temperature, vomiting, and sudden death. During 1927 six fatal cases were recorded among the large number of patients injected with tartar emetic. Khalil states, however, that it is certain that this official number of deaths is very much below what is expected, and that there is no doubt that many cases are concealed by their relatives in order that they may avoid postmortem examination and legal investigations.

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[1] Brumpt: Bull. Acad. Med. (1928), C, 813.

[2] Cameron: Jour. Helminthology (1928), VI, 219.

[3] Blackmore: Jour. Royal Army Med. Corps (1928), LI, 262.

[4] Khalil: Jour. Egyptian Med. Assoc. (1928), II, 97.

In connection with the treatment of schistosomiasis in Africa, Dr. Shattuck[1] has recommended the use of the less toxic antimony preparation sodium thioglycollate which is relatively non-irritating when injected intramuscularly. The toxicity of this drug is certainly less than that of tartar emetic which is now generally employed in the treatment of schistosomiasis (Chapter XXXI).

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[1] Shattuck and Willis: Jour. Trop. Med. and Hyg. (1928), XXI, 115; see also page 499 of this Report.

XVII

FILARIASIS

Filariasis is prevalent both upon the coast and in the interior of Liberia. All the usual forms of filarial infection were met with, although filariasis was nowhere found to prevail very extensively. In the interior at Gbanga, about the geographical center of Liberia, a series of 105 natives were examined, 92 of the examinations being made at night. *Filaria (Wuchereria) bancrofti* was found in two instances, *Acanthocheilonena perstans* in one instance and *Loa loa* in one instance.

With reference to the transmission of filariasis in Liberia, *Culex fatigans (C. quinquefasciatus)*, perhaps the most usual transmitting insect of *Filaria bancrofti*, was found to be present in great abundance in many localities in Liberia and, indeed, was often the most common domestic mosquito encountered. Edwards [1] has demonstrated that complete development of *F. bancrofti* may occur in *Taeniorhynchus africanus, Anopheles rossi, A. costalis*, and *A. algeriensis*, as well as *Culex pipiens*. Of these only *A. costalis* has been found in Liberia.

Both species of the mangrove fly, *Chrysops dimidiatus* and *C. silacea*, which have been demonstrated by Leiper and by Connal and Connal [2] to be the carriers of *Loa loa*, have been previously reported as having a wide distribution on the West African coast. In addition, other species of *Chrysops* were found during the present Expedition by Dr. Bequaert in Liberia and the Belgian Congo (see page 889).

Very recently Sharp [3] has given evidence of the transmission of *Acanthocheilonema perstans* by *Culicoides austeni* and *C. grahami*. The earlier work was done with the second species and then continued with *C. austeni*. Sharp, working in Nigeria, found that after feeding upon an infected individual the embryos of *A. perstans* were ingested by the insects and that they then underwent metamorphosis in the thoracic muscles in the usual manner of filarial embryos. It was observed that the metamorphosed larvae reached the head and neck of the fly by the seventh day after feeding. They then pass to the proboscis, from which they escape by stretching, and finally bursting the terminal membranous portion of the labrum eight to ten days after feeding. Transmission of the parasite from insect to man was not witnessed, owing to the very minute dimensions of the mature larvae, but Sharp points out that from his investigations there is strong presumptive evidence that *C. austeni* is an efficient vector of *A. perstans* from man to man and that it is probable that *C. grahami* will also prove to be a natural carrier of this parasite. He points out

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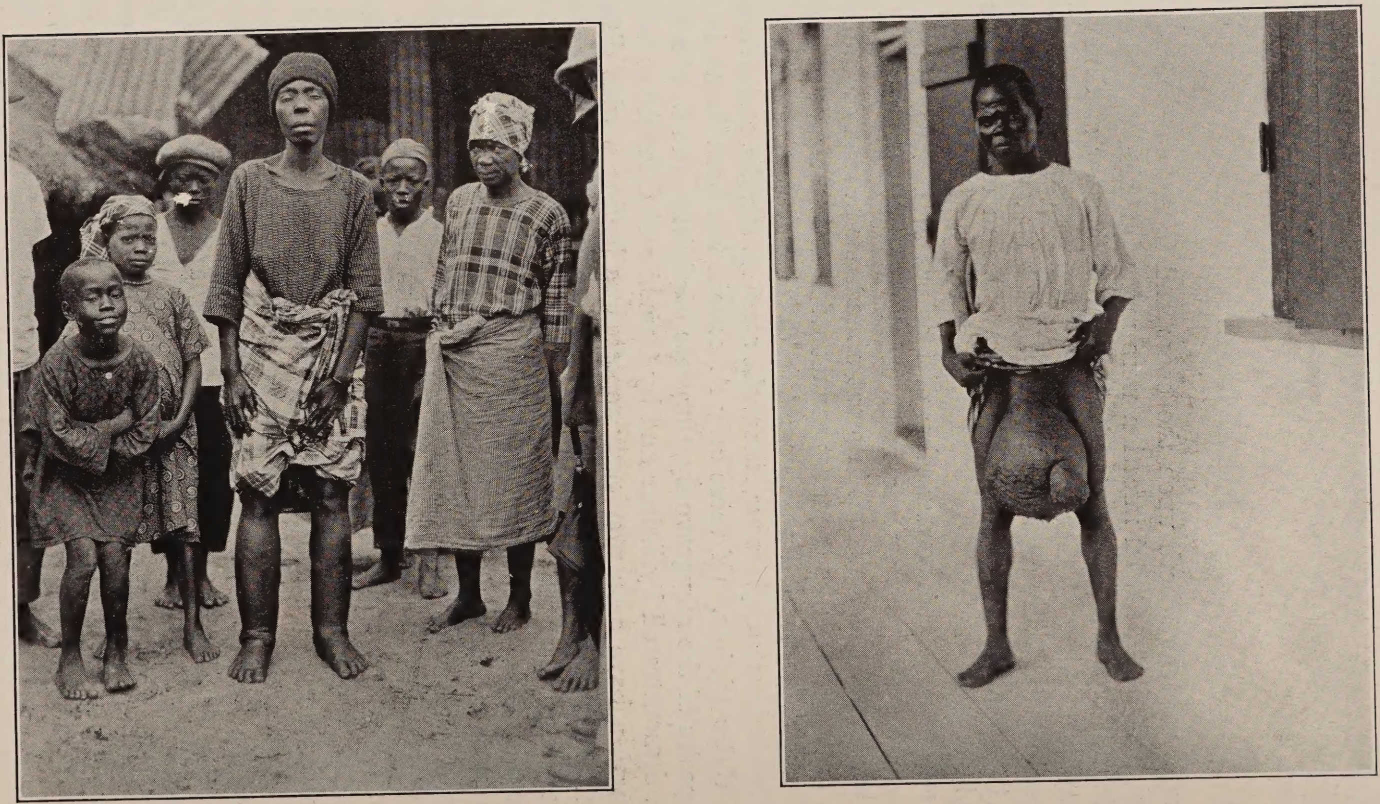
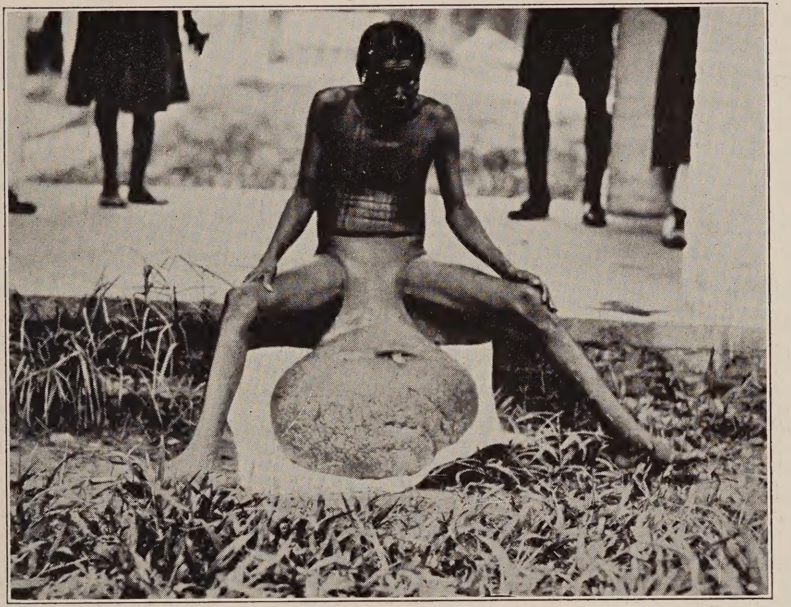
[1] Edwards: Jour. Trop. Med. and Hyg. (1922), XXV, 168.

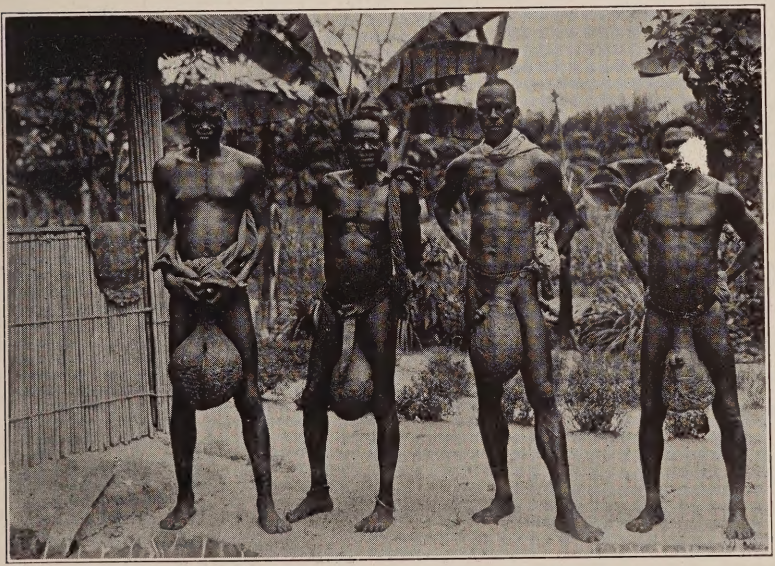
[2] Connal and Connal: Trans. Royal Soc. Trop. Med. and Hyg. (1922), XVI, 64.

[3] Sharp: Trans. Royal Soc. Trop. Med. and Hyg. (1927), XXI, 70; and (1928), XXI, 371.



Nos. 170, 171. — Forms of elephantiasis observed in Liberia





Nos. 172, 173. — Elephantiasis of the scrotum, in the Belgian Congo that only the female fly bites and that darkness is essential for this; even a candle placed within a tent would keep *Culicoides* away and a full moon would give almost complete protection from bites. This fly furthermore showed a decided tendency to bite black rather than white skins.

At Mamfe in the British Cameroons, Sharp found over seven per cent of the wild flies to be naturally infected with *A. perstans*. He remarks that the incidence of infection in the natives in this region is not less than 92 per cent. This is obviously far greater than it is in Liberia. This species has been found by Ingram and Macfie to be widely distributed in Sierra Leone and is also known to prevail in many other localities along the West Coast.

Culicoides grahami was collected by Dr. Bequaert both in the interior of Liberia and in the Belgian Congo. This midge, however, was not found in very great abundance in Liberia during the time that we were in that country.

Most authorities including Stephens and Yorke [1] attribute no definite symptoms of disease to *Acanthocheilonema perstans*. However, Morenas [2] has recently reported a case of infection with this parasite in which there was an eosinophilia of fifty per cent and attacks of urticaria and of fugitive oedema with localized tumors of the nature of Calabar swellings. Later dyspnea and oedema of the legs occurred and the patient succumbed. At the necropsy there was cardiac thrombosis, myocarditis, with hypertrophy of the spleen and of the liver. Morenas thinks the eosinophilia and cutaneous symptoms were due to *A. perstans*.

Elephantiasis in its more advanced forms, particularly of the lower extremities and scrotum, was also found to be common in Liberia and particularly among the adult Krus. Speaking generally, the cases of elephantiasis were more common and advanced among the people of Liberia on the coast than among those in the interior. The condition was, however, even more frequently met with in parts of the central Belgian Congo. In the hospitals of the Belgian Congo it was not infrequent to observe several patients with elephantiasis of the scrotum who had come for operation. The tumors not infrequently weighed from twenty-five to seventy-five pounds (No. 172). Although the surgical technique is often not very good in some of these Belgian hospitals, the patients usually recover after operation and removal of the growth.

The skin of the more advanced cases of elephantiasis, while sometimes smooth, is generally rough, thickened, fissured and papillomatous. This latter condition, when well developed, has been frequently referred to under the name of elephantiasis verrucosa. Very early papilloma may be observed upon the scrotum in the case illustrated in No. 171. At times in elephantiasis of the lower extremities, the closely placed papillomata present a very striking appearance, so much so that occasionally the condition might be confused with that described as "mossy foot." Buxton [3] also illustrates this verrucous condition in filariasis in researches in Polynesia and Melanesia.

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[1] Stephens and Yorke: "Practice of Medicine in the Tropics," edited by Byam and Archibald (1923), III, 1948.

[2] Morenas: Bull. Soc. Path. Exot. (1929), XXII, 325.

[3] Buxton: London School Trop. Med., Memoir Series (1928), No. 2.

Anderson [1] in his report on filariasis in British Guiana, in describing the clinical aspects of filariasis, states that a fourth type is the variety known as "filariasis verrucosa," on account of the very coarse, warty appearance of the skin. The warts and small bosses appear in greatest profusion around the lower part of the calf and the dorsum of the foot.

Breinl [2] working in Australia, reported two cases of elephantiasis of this nature. These we have discussed in our previous report of the Amazon Expedition.[3]

In one of our cases observed in the Belgian Congo (Case 580) the foot was covered with bristle-like, closely placed papillomata. The patient was a negro about twenty-two years of age with a skin otherwise clear. The abdomen was prominent, but the liver and spleen were not palpable. The lower legs and especially the ankles were moderately oedematous, and the dorsa of the feet were much swollen. The skin about the ankles was deeply folded and covered with fine, bristle-like papillomata. The upper surface of the foot, the ends of the toes, the sides and back of the foot showed similar changes. The toenails were thickened, irregular and cracked and the soles of the feet were thickened and oedematous. A note was made at the time that the appearance of the foot resembled that described by Breinl under the term "mossy foot." Pieces of the tissue were excised and, after washing them in 95 per cent alcohol for three minutes, were cut into with a sterile knife and cultures made from the cut surface on Sabourraud's media. A number of white and lightly yellow-tinged colonies developed on the surface of the media. These were found to consist of cocci, some small and others considerably larger in diameter. Other pieces of tissue were hardened in Zenker's solution and in ten per cent formalin, and later sectioned and stained. Histological study of the tissues shows that there is great thickening of the stratum corneum and in places there are large numbers of cocci and a few blastomycetic forms lying both above and between the layers of cells. They are particularly abundant where the cells are pressed apart from the oedematous condition. There is also a marked hyperplasia of the stratum mucosum. The corium in a number of areas shows marked infiltration of endothelial and polymorphonuclear leucocytes. There is also marked infiltration about the sweat glands. In places, between the individual papillomata, fissures and breaks have occurred, extending from the surface of the corneal layer downward through the epithelial layer and into the papillary layer of the corium. Within and along the margins of these channels, lying in the albuminous material containing a few red blood cells and fair numbers of leucocytes, are seen large numbers of cocci and a few torulae. These organisms have also infected the corium for some distance away from the margins of the fissures and in the tissue about them there is much proliferation of the endothelial leucocytes and polymorphonuclear cells. Many other degenerating connective tissue cells are seen in and about these areas. In the deeper tissue there are evidences of chronic hyperplasia. There is endothelial proliferation about most of the vessels and the lymph spaces are sometimes almost occluded. However, in other areas hyperplasia of the lymph vessels has been brought about, giving an alveolar oedematous appearance to the tissue. Apparently the micro-organisms invading the surface of the skin are of a low grade of virulence that do not produce toxins capable of giving rise to a more acute inflammatory process which might result in the formation of abscesses. No doubt the inflammatory condition of the tissues resulting from the presence in or the blocking of the larger lymph vessels by the filaria primarily produces a condition, which together with the irritation resulting from scratching, is very favorable for the invsion of the deeper tissues with micro-organisms from the surface of the skin.

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[1] Anderson: London School Trop. Med., Research Memoir Series (1924), vol. V. Mem. 7, p. 14.

[2] Breinl: Report of Australian Inst. of Trop. Med. (1910).

[3] Strong and Shattuck: *Loc. cit.*, p. 40.

This case recalls particularly one of our Brazilian patients in which there was elephantiasis and "verrucous dermatitis" and in which no fungi but only cocci were found in the deeper lesions. The subject of the etiology of mossy foot and verrucous dermatitis was fully discussed in the report of the Amazon Expedition [1] in which it was noted that fungi had in some instances been cultivated from such lesions and that in other cases no fungi had been encountered. The opinion of Rojas [2] was concurred in to the effect that mossy foot and verrucous dermatitis as it has been described, is not a distinct morbid entity and constitutes an elephantoid condition of the skin which may arise from one or more of several causes.

In this same report [3] we have also called attention to the frequent secondary infection in filariasis with cocci and noted especially the attention which has been called by Stephens and Yorke [4] and Anderson [5] to the importance and the frequency of such bacterial infections in cases of elephantiasis. The importance of bacterial infection especially haemolytic streptococci in the production of elephantiasis has recently been emphasized by Acton and Rao,[6] and Grace.[7]

Under the term dermatitis verrucosa (chromoblastomycosis), Mayer [8] illustrates a case with lesions of the foot and leg, reported by Rocha Lima in which *Blastomyces* were encountered in the tissues. The parasites were round, refractile and brown in color, hence the name chromoblastomycosis has been given to the condition. Apparently Mayer also considers that *Phialophora verrucosa* and *Acrotheca pedrosiana* which have been found by other observers in some cases termed dermatitis verrucosa are not yeasts. Castellani in his monograph of Fungi and Fungus Diseases [9] does not refer to *Phialaphora verrucosa* and *Acrotheca pedrosiana* or to the subject of chromoblastomycosis.

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[1] *Loc cit.*, pp. 40–47.

[2] Rojas: Chronica Med. Lima. (1923), XL, 361.

[3] *Loc cit.*, p. 123.

[4] Stephens and Yorke: "Practice of Medicine in the Tropics," ed. by Byam and Archibald (1923), III, 1922.

[5] Anderson: London School of Trop. Med., Research Memoirs (1924), Vol. V. Mem. 7.

[6] Acton and Rao: Indian Med. Gazette (1929), LXIV, 631.

[7] Grace: Proc. Royal Soc. (still unpublished).

[8] Mayer: "Exotische Krankheiten" (1929), p. 325.

[9] Castellani: Arch. of Derm. and Syph. (1927–1928).

Filarial Cyst. On the Upper Congo, near Stanleyville, through the courtesy of Dr. Chesterman, we observed in the hospital a case (No. 560) with a small tumor, about 5 cm. in diameter, situated on the right arm, about 6 cm. above the elbow and lying along the inner aspect of the biceps muscles in the subcutaneous tissue. It was freely movable, soft and cyst-like. The examination of the peripheral blood from the ear showed long, thin, filarial embryos with a sheath which from the examination of stained preparations suggested *Microfilariae loa.* Microscopical preparations made from the inner wall of the tumor showed a number of red blood corpuscles and a few similar microfilariae. The tumor was removed by Dr. Chesterman and was kindly turned over to us for examination. It was fixed in formalin and proved to be a thin-walled cyst containing straw-colored fluid and a single parasite about 5 cm. in length lying free in the fluid. The worm was later identified as an adult female *Loa loa.* This is apparently the first reported instance of the formation of a cystic tumor by this parasite. A section through the wall of the cyst is illustrated in No. 175. Neither Sticker, Schuffner, and Swellengrebel [1] or Fülleborn [2] in his monograph on Filaria of Man, refer to such a lesion produced by *Loa loa.*

The adult *Loa loa* have been found in connective tissue in many parts of the body, particularly in the subcutaneous tissue, under the muscular aponeurosis of the muscles of the extensor surfaces of the arms, for example. Stephens and Yorke refer especially to such location, and also mention the occurrence of the parasites on the surface of the organs in the mesentery, under the parietal peritoneum and pericardium, encysted in the tunica vaginalis, and heart muscle, in the anterior chamber of the eye, under the ocular and palpebral conjunctivae, over the bridge of the nose and in the frenum linguae. According to these authors, Ziemann has attributed inflammatory swellings, both in muscular and connective tissue, which may suppurate, to infection with *Loa loa.*

There is no evidence of inflammatory change in the cyst wall of our tumor and there is no cellular infiltration of the surrounding connective tissue. The cyst probably represents a dilatation of a gland-like cavity. It appears as though the fibers of the surrounding tissue had gradually been pressed apart by the movements of the parasite and the slowly accumulating fluid. In the surrounding tissues a few millimeters outside the cyst wall, there are wavy bands of areolar connective tissue with a few red blood cells and leucocytes lying within the interstices. Lying upon the right side of the cyst wall is a protrusion of the tissue composed of unstriped muscle fibers whose origin is not entirely clear. It seems probable that the parasite originally developed to its adult size within a lymphatic vessel whose walls gradually became occluded. It, however, is impossible from the structure of the cyst wall to decide whether the tumor was formed originally about a lymphatic vessel.

In connection with the production of this filarial cyst, it is of some interest to refer to the report of Rose[1] published from British Guiana upon a peculiar modification of the skin about an infection with *Wuchereria* (*Filaria*) *bancrofti*. In two cases, he found upon the anterior surface of the forearm, small, rather solid, somewhat translucent nodosities of the skin. They contained serum and a mixture of red blood corpuscles. In both cases, *Microfilariae bancrofti* were demonstrated in the contents.[2]

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[1] Sticker, Schuffner, and Swellengrebel: Mense's "Handbuch der Tropenkrankheiten" (1929), V, 309.

[2] Fülleborn: "Handbuch der Pathogenen Mikroorganismen" (1929), VI, 1171.

Suganuma[3] has also reported upon a case of teratoid tumor from the abdomen of a child six months of age, which contained pieces of a nematode which may have been *Wuchereria bancrofti*. The surrounding tissue was said to show inflammatory changes with a tendency to malignancy.

The Calabar swellings due to the migration of *Loa loa* are, of course, of a transitory nature. According to Fülleborn, they are an evidence of a reaction of the host body to *Loa* antigen (anaphylactic phenomena), but he has not been able to produce them by inoculation of extracts of *Loa loa* into a patient predisposed to Calabar swellings. Other observers have attributed these swellings to the movements of the adults in the tissues or to the discharge of embryos into the tissues by a mature female, as puncture of the swellings has sometimes shown large numbers of embryos in the oedematous fluid.

Caro[4] has recently reported upon two cases of Calabar swellings which incline him to the view that these swellings are not definitely connected either with the migration through the tissues of the adult parasite or with the discharge of embryos, and he suggests that some toxin or faecal excretions of the parasite may be the exciting cause. This view has also been especially put forward previously by Ward.[5]

Low,[6] in connection with the distribution of *Loa loa* infection in central equatorial Africa, points out that he has observed a number of cases of Calabar swellings in European missionaries from the Belgian Congo, several of whom have had the adult worms in the eye and the embryos present in the blood. He remarks that it is no exaggeration to say that if persons reside in these localities for more than five years they are certain to become infected. These areas are particularly Niangara and Nala in the Haut Wellé Province and Ibambi in the Ituri Province. He remarks that the distribution of *Loa loa* extends from southern Nigeria, the Cameroons and the French Congo, into the heart of Africa, in the Belgian Congo.

Füllebornia (*Dracunculus*) *medinensis*. Johnston[7] implies that the guinea worm *Füllebornia medinensis* is very common in Liberia; in fact it is the only parasite and diseased condition which he describes at length in his book upon

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[1] Rose: British Guiana Med. Ann. (1923), p. 67.

[2] While this article was in press, Klotz (Amer. Jour. Trop. Med., 1930, X, 57) has reported upon a form of nodular fibrosis of the spleen which was believed to have its origin in a slow growth of fibroblasts in the vicinity of the malpighian corpuscles through the irritation induced by microfilariae. Although the adult filaria was not found at autopsy, he believes from the study of the morphology of the microfilariae in serial sections of the block of the spleen that the parasite concerned was *Filaria* (*Loa*) *loa*.

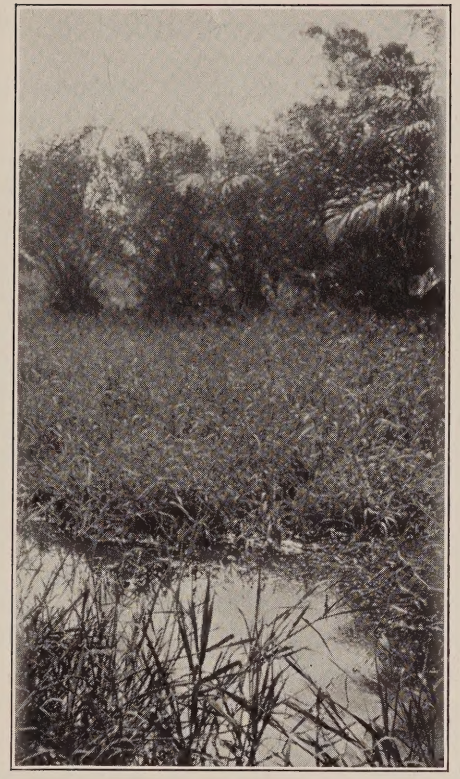
[3] Suganuma: Jour. Med. Assoc. Formosa (1927), No. 266, p. 4.

[4] Caro: Bull. Soc. Path. Exot. (1927), XX, 977.

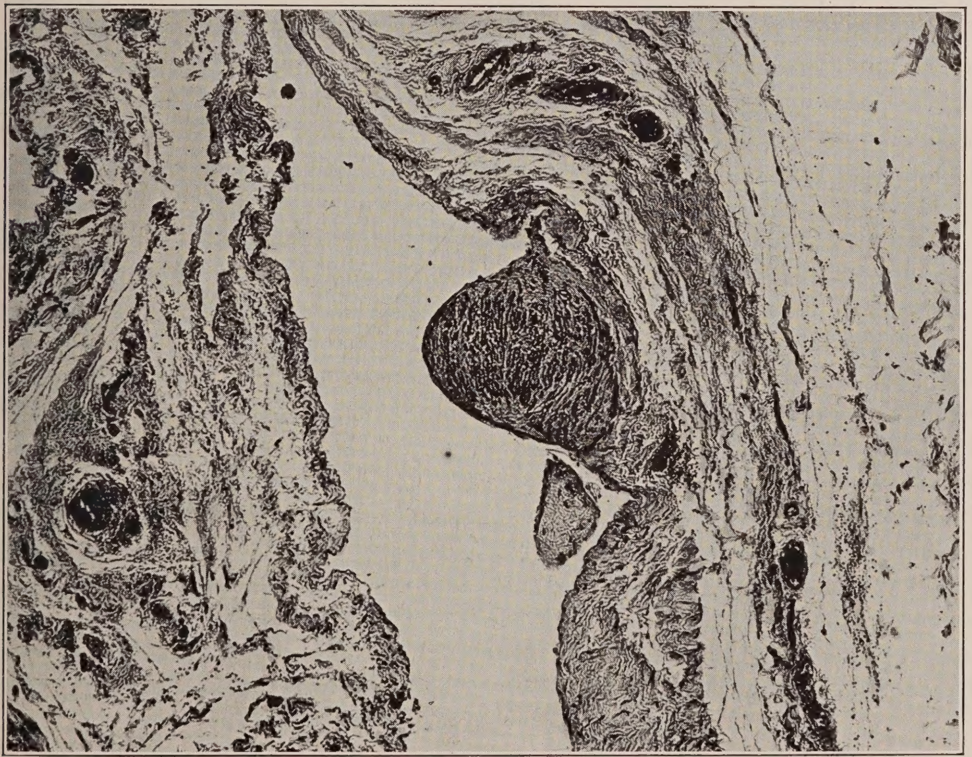
[5] Ward: Jour. Infec. Dis. (1906), III, 37.

[6] Low: Trans. Royal Soc. Trop. Med. and Hyg. (1926–1927), XX, 514.

[7] Johnston: *Loc. cit.*, II, 981.



No. 174. — Swamp at Yakusu in which *Physopsis africana* (host of *Schistosoma haematobium*) was collected



No. 175. — Photomicrograph of section of cystic tumor produced by *Loa loa*, Case 560

the country. Actually the infection is not common in Liberia. Only one case was brought to our notice by Dr. Willis while we were in the country. The individuals observed in Liberia afflicted with this parasite are usually travellers coming from more central and drier regions of Africa.

Roussel[1] has recently shown that repeated local injections of such drugs as cocaine, formalin, chloroformization of the parasite, etc., as well as general chemotherapeutical measures such as the intravenous injection of novarsenobenzol and tartar emetic and the intramuscular and intravenous injections of emetine, as well as the ingestion of stovarsol, all failed to destroy the parasite *Dracunculus medinensis*. In three patients he repeatedly tried all these methods of treatment without success. In one instance in which more than 100 microfilariae were expelled, the patients had received successively 4 85 grams of novarsenobenzol in seven injections and ten injections of emetine. The adult parasite apparently remained unaffected. Roussel has also shown by injections of lipiodol into the body cavity of the parasite at the extremity which points to the skin, that excellent radiograms showing the location of the worm sometimes may be obtained. These radiograms illustrate the impracticability of attempting to remove the parasite by surgical operation owing to its very extensive ramifications. The radiograms in addition show that the worm is found in the connective tissue and not in the muscles.

ONCHOCERCIASIS

Infection with *Onchocerca volvulus* was first observed in the interior of Liberia at an altitude of some 900 feet. In this same region we observed in considerable numbers a species of black fly, later identified as *Simulium damnosum*. At one of our camps situated at Gbanga, near the geographical center of Liberia, an especial search and study was made regarding this fly. We were successful in finding its breeding place about a mile from our camp in a swiftly-flowing stream (Nos. 176, 177) whose banks were bordered by narrow belts of low forest or by rice fields.

The larvae and pupae of the flies were found fixed on the bottoms and sides of stones which were lifted from the swiftly-flowing stream, and attached to leaves of branches of trees immersed in the water. They apparently adhere to the stones and leaves by means of a circle of spines at the caudal end and a sticky substance secreted from the mouth. The pupa is enclosed in a boat-shaped cocoon (Text Fig. No. 6, page 857). A number of the adult flies were collected from the banks of the stream. They are small, about three millimeters long, and almost black (Text Fig. No. 4), and are commonly found in the bush and grass in the vicinity of the water. A more complete entomological description of them is given on page 852. They seem to prefer shade and humidity and will not bite in the bright sunlight. Only the female has been found biting during the day in shady places. The insect makes no sound when flying and alights quietly upon the skin. Bequaert has carefully studied and described the larvae and pupae of this fly. The adult flies captured on the banks of this

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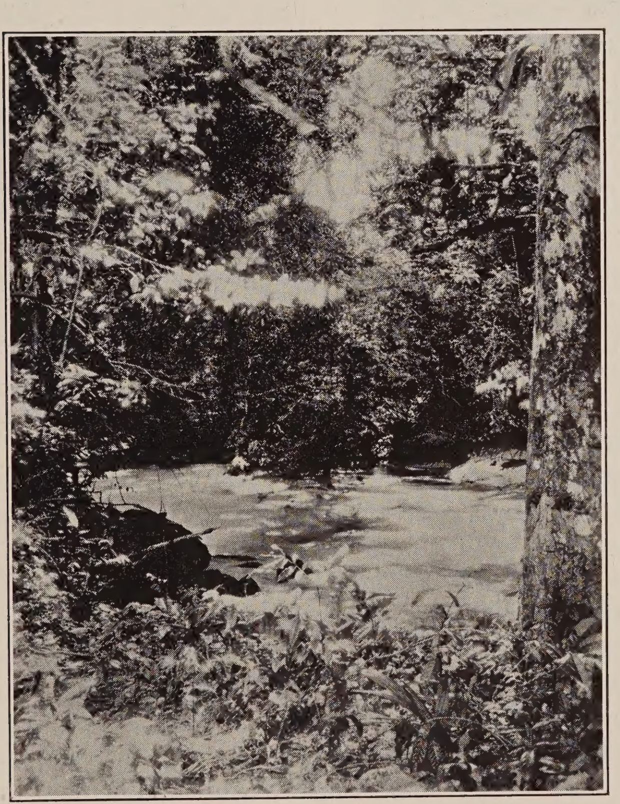
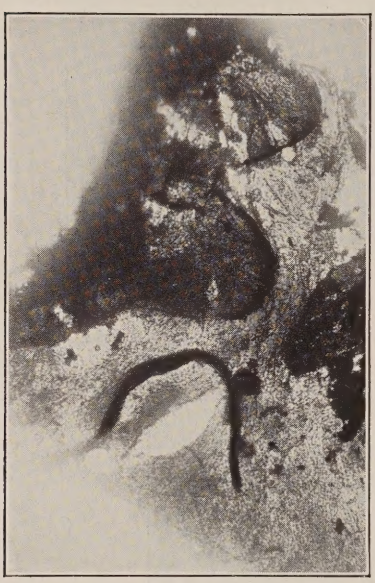
[1] Roussel: Bull. Soc. Path. Exot. (1928), XXI, 103.

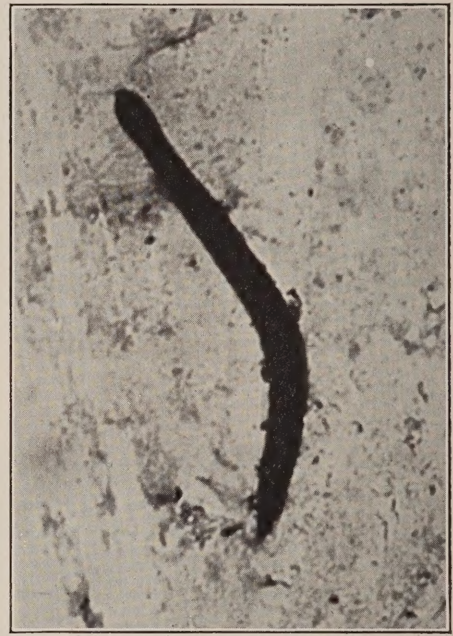


Nos. 176, 177. — Regions in which *Simulium damnosum* was found breeding, at Gbanga, Liberia stream correspond in all respects to *Simulium damnosum.* It seems exceedingly probable that the larvae and pupae are also of this species. However, Bequaert's description does not coincide with that previously given by other authors and it would appear as though his description of the larvae and pupae of *Simulium damnosum* given in this Report is the correct one.

Simulium damnosum is widely distributed in parts of the equatorial regions of Africa. In places it is known as the Jinja fly, and in Uganda it is called *mbwa.* In the Congo we found it particularly about Leopoldville. These flies bite particularly on the bare legs of the natives, and many of them rested on the backs of our brown leather leggins or boots.



No. 178. — Form undergoing ecdysis



No. 179. — Advanced thoracic form

Photomicrographs of larval forms of *Onchocerca volvulus* in *Simulium damnosum*

On several different occasions, adult flies were collected from the banks of this stream and dissected, but no filarial larvae were ever found in them. However, later, in *Simulium damnosum* collected when biting near the village and about our camp, the filarial embryos were found both in the gut and later in the thorax of the flies. In one fly caught about our improvised laboratory, five motile larvae were found in the thoracic segment of the insect and three in the abdominal one. In another fly, also caught in this laboratory, at least five larvae were found in the thoracic muscles. The thoracic forms are not so motile as those seen in the gut. One of their characteristics is that they have a movement of the caudal extremity without changing position on the slide. In the thoracic muscles they have also increased in width and the caudal appendage is peculiarly spine-like, and either straight or curved (No. 179). The parasite greatly increases in length in this region, to three times its former size. Our observations with reference to *Simulium damnosum* as the transmitter of *Onchocerca volvulus* are apparently the first to confirm the very important ones of Blacklock,[1] already published several months before our observations were made. Brumpt had suggested that several insects might transmit the parasite to man, and Rodhain, Van den Branden, and Blanchard and Laigret performed experiments with certain mosquitoes, flies, bedbugs, and ticks without, however, demonstrating insect transmission of the parasite (see page 850). Robles,[2] in Guatemala, also had previously suggested, even before Blacklock's findings, that coffee flies, *Simulium dinellii*, might transmit *Onchocerca caecutiens*, but he made no investigation of any kind on the subject.

Blacklock [3] found that larvae ingested by *Simulium damnosum* leave the gut within twenty-four hours and within forty-eight hours have reached the thorax, by which time they have become stumpy forms with the characteristic caudal appendage. After several moults they pass to the head and proboscis, about seven or more days after infection. He also observed that heavy infection appears to be fatal to the insect. By allowing wild flies to feed on heavily infected areas of the skin in human cases the gut infection of the flies was raised to eighty per cent in one experiment and the thorax infection to nearly eighty-two per cent in another experiment. The developing forms of *O. volvulus* were found in the thorax after the infecting feed up to the seventh, eighth, and tenth days, after which period no insect survived. Blacklock also attempted to infect two monkeys, which were inoculated intra- and subcutaneously, the first in the flank and the second in the head, with advanced forms of larvae contained in the heads of the flies. Neither of the monkeys showed any important reaction, the incisions healing by first intention, and they had shown no evidence of infection up to the time the report was published. Perhaps the species of monkey employed (not stated) might not be susceptible to *Onchocerca* infection.

From Blacklock's observations, confirmed by our own, it would appear that *Simulium* has at least been shown to harbor a parasite pathogenic for man.

An actual demonstration, by biting experiments, that this fly transmits the filariae to man, would for obvious reasons be very difficult. However, there is no reason to doubt that the fly when feeding on human cases of infection ingests the embryonic form of the filaria, and it has been demonstrated that some transformation and development of the filaria takes place in the fly.

From all the evidence available, it seems highly probable that *Simulium damnosum* is the natural agent of transmission of the infection.

It was formerly repeatedly claimed that *Simulium samboni* was the transmitting agent in pellagra, but there was never any experimental proof of this and the idea has since been proved to be erroneous.[4] It has also been suggested that *Simulium* may sometimes transmit cutaneous leishmaniasis and anthrax.

Simulium amazonicum is very common in the Amazon basin along the Rio Branco. We dissected large numbers of these flies there in 1924 but never found any infected with parasites, and we have only found filarial embryos in *Simulium damnosum* in localities where *Onchocerca* infection was present.

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[1] Blacklock: Ann. Trop. Med. and Parasit. (1926), XX, 1.

[2] Robles: Bull. Soc. Path. Exot. (1919), XII, 448.

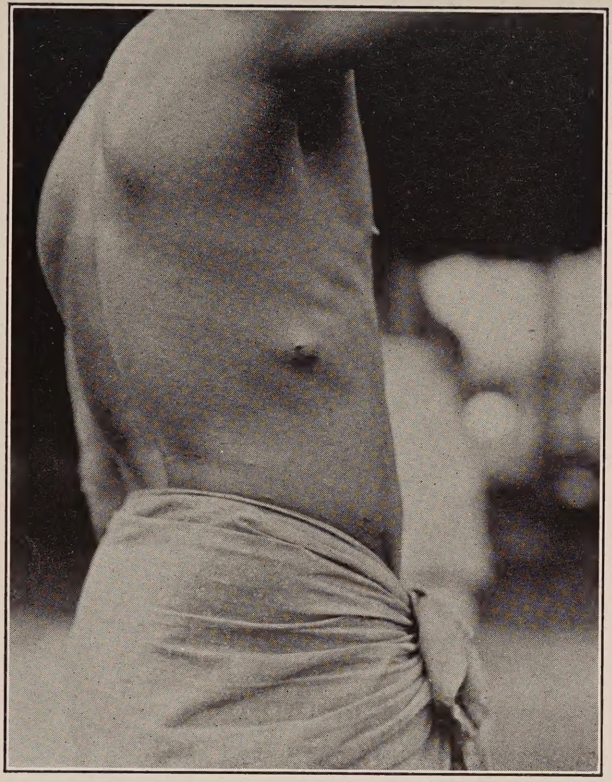
[3] Blacklock: Ann. Trop. Med. and Parasit. (1926), XX, 203; Brit. Med. Jour. (1927), p. 219.

[4] Sambon: Jour. Trop. Med. and Hyg. (1910), XIII, pp. 271, 287, 290, 305, 319.

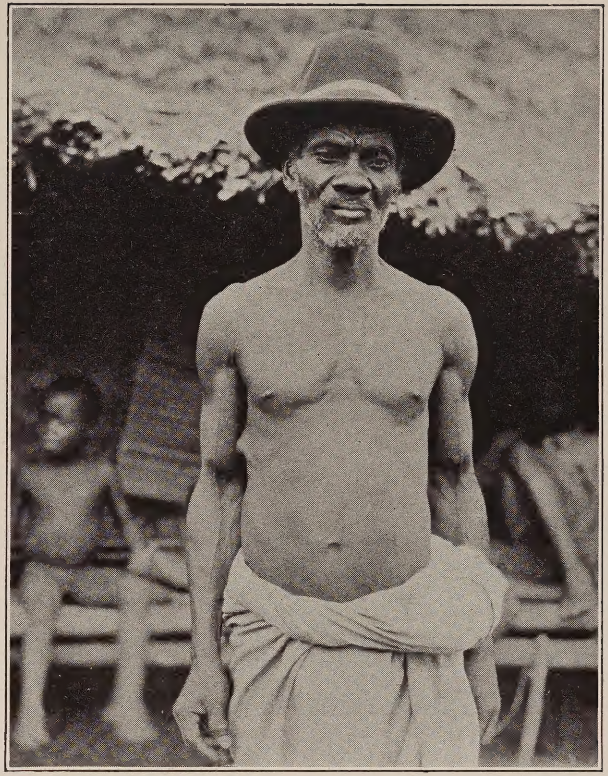
Thus in the same region in Liberia where infected *Simulium* were found (as well as in adjacent territory), we discovered individuals with tumors caused by infection with *Onchocerca.* Photograph No. 180 illustrates the tumor of the first case encountered in Liberia. The patient (Case 340) was a large, well-developed and well-nourished native. He complained of some pain in the right side of his chest. On the right side of the chest wall, in the axillary region, between the sixth and seventh ribs, was a projecting tumor about the size of a hen's egg located in the subcutaneous tissue, and firm to the touch. The skin over the tumor was not adherent and the tumor was so loosely attached as to be freely movable. On palpation it was found to be hard, slightly lobulated and not apparently tender. The skin above the tumor appeared to be normal. Microscopical examination of the blood from the ear and of a section of the skin made from a small papule on the wrist did not show any parasites. However, microscopical examination of a thin section of the skin immediately over the tumor revealed numerous motile embryos of *Onchocerca,* — the forms which are diagnostic of the infection. Sometimes the parasites are seen still enclosed in a sheath of the ovum (No. 183).

Pathology. This tumor on removal measured 2.5 cm. long and 12 mm. wide. It was enclosed in a smooth, connective tissue capsule, grayish white in color and not very vascular, but a few small blood vessels could be seen with a hand lens. On cut section, the capsule was about 2 mm. in diameter. Attached to this main portion of the tumor was a smaller growth, 11 mm. in diameter, with a somewhat more vascular thin capsule. The cut section of both of the tumors was yellowish gray, the center becoming more orange in color. The center of the tumor was of softer consistency than the periphery. From the center of the nodules were expressed pieces of the adult parasites with embryos and ova. The ova have a very thin outer membrane and within the embryos may be seen in various stages of development. Two types of larval forms are found free: larger, palely-staining forms, and smaller, more compact ones with deeply-staining nuclei.

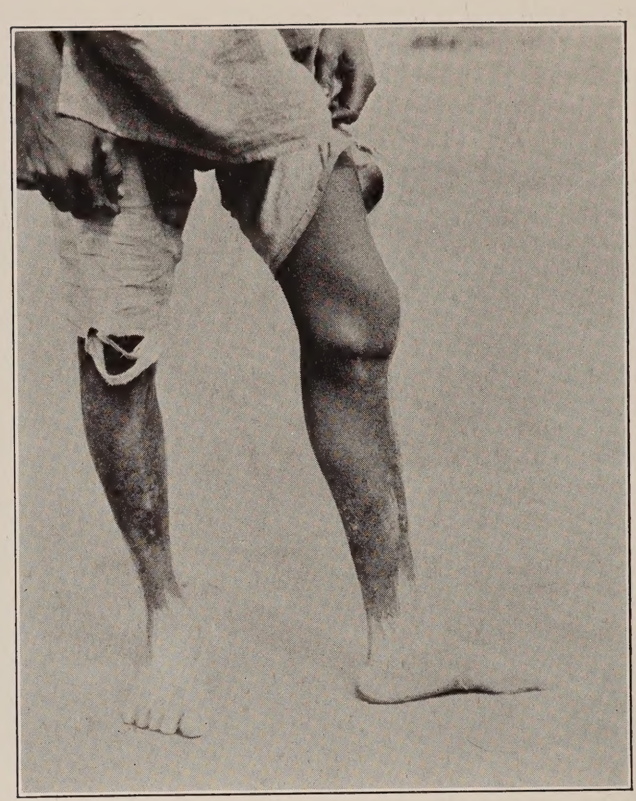
Tumors of similar appearance, varying in size from about 2 to 6 cm. in diameter were removed from the subcutaneous tissue from six patients. Other cases were seen elsewhere in Liberia and about Leopoldville in the Belgian Congo. At Leopoldville, through the courtesy of Dr. Van den Branden and Dr. Duren we were permitted at their clinic to examine seven such cases and to remove tumors from three of these patients. Portions of all of them were immediately placed in Zenker's solution or in formalin. The onchocercal tumors are commonly located about the chest wall, particularly in the lateral regions, occasionally on the dorsum. They are also found in the neighborhood of the joints, more rarely in the axilla. As a rule, they are more firm at the periphery, but there are often soft areas in the more central portions, particularly in those areas which have a yellowish or orange color. It is in these soft areas or cavities that the adult parasites are particularly found.



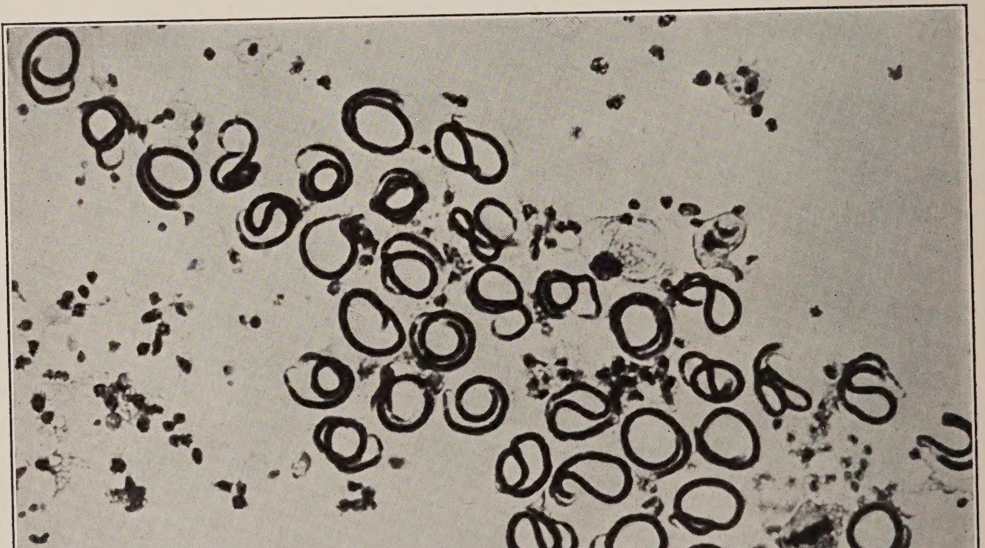
No. 180. — Case 340



No. 181. — Case 411



No. 182. — Tumor produced by *Onchocerca volvulus*, Case 498



No. 183. — Photomicrograph of larval form of *Onchocerca volvulus*; moist film preparation made from cut section of tumor

Histological examination of the different tumors collected in various localities in Africa, show that they are all fibromata. In the center, sections of the adult parasites are commonly found (No. 184) usually imbedded in the connective tissue stroma. Immediately about the parasites there is often some evidence of irritation caused by the parasite itself. A few polymorphonuclear leucocytes are scattered about with small round cells, occasionally plasma cells, and eosinophils. Outside of these areas the tumor is composed largely of fibrous connective tissue. Here the fibroblasts are few in number and the fibroglia fibrils are not abundant. The tumor is composed particularly of collagen fibers forming wavy bundles (No. 186). In none of the tumors do the cells show marked evidence of mitotic division, nor are numerous giant cells present, so there is no evidence that the neoplasms are formed very rapidly.

From an examination of Photomicrograph No. 188 it may be seen that sometimes there is no evidence of inflammatory change about the sections of the adult parasites which are surrounded on all sides by wide bands of connective tissue in which collagen fibers predominate. In other instances there is a clear space about the section of the parasite (No. 189) which is partially surrounded by a thin layer of coagulated lymph in which fibrin and small round cells, and polymorphonuclear leucocytes as well as a few plasma cells, are visible. The surrounding connective tissue in such sections (taken apparently from tumors or areas of more rapid growth) is much richer in nuclei. These nuclei are more often round or oval, but are sometimes spindle-shaped. In some areas the appearance is somewhat suggestive of the condition observed in fibrosarcomata. Giant cells are present in some areas but are not abundant. In certain portions of the tumor the eosinophils are markedly increased, a condition, however, not usually found in the immediate vicinity of the sections of the adult parasites. Sometimes small clumps of eosinophils are observed. The microfilariae (No. 190) are found in large numbers in many but not in all parts of the tumors. In many areas in which they are prevalent, the round or oval nuclei of the fibroblasts predominate in the surrounding tissue. Frequently there is a clear space or opening in the tissue about the organisms. Rarely are there accumulations of round cells or polymorphonuclear leucocytes about them, but such reaction is present in a few areas.

There seems to be no doubt but that the parasite is the inciting factor in the formation of the neoplasms.

Other Pathological Effects Caused by Onchocerca. A marked difference is noted with reference to the larvae of *Onchocerca volvulus* and the microfilariae of *Wuchereria bancrofti* and *Acanthocheilonema perstans*, in that the larval forms of *Onchocerca* are rarely present under normal conditions in the circulating blood. When they are encountered among blood cells their presence usually may be explained by the fact that lymph spaces have been punctured in securing the specimens. Sharp [1] who examined the blood of 2000 cases, examined by thick film method, found that the embryos occurred in eight per cent. The larval forms of *Onchocerca*, however, as we have illustrated, are usually found in considerable numbers in the skin of infected cases and also in the lymphatic glands.

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[1] Sharp: Proc. Royal Soc. Med. (1927), XX, 41.

A number of observers have described lesions of the skin due, they believe, to the larval forms of *Onchocerca*, such as filarial itch or craw-craw, pseudo-ichthyosis, xeroderma and lichenization. Montpellier and Lacroix [1] in the examination of native troops in Africa suffering with a form of itch, or craw-craw, constantly found microfilariae in the dermal layer of the skin and independent of the vascular network. They conclude that the craw-craw described by O'Neil in 1875 is a form of filarial itch and a dermal manifestation of onchocerciasis.

They also noted [2] a constantly high increase in the eosinophile cells in the blood, but the total number of leucocytes was not increased. The maximum eosinophilia, they said, seemed to occur at each discharge of microfilaria into the blood.

Ouzilleau, Laigret, and Lefrou [3] report that subjects infected with *Onchocerca volvulus* also have microfilariae in the dermis. They believe that the microfilariae create inflammatory reactions in the skin which manifest themselves by pseudo-ichthyosis, elephantiasis of the genitalia, and in other parts by achromia and cutaneous atrophy. They found an infiltration of the connective tissues with mononuclear cells in the dermis, with embryos of *O. volvulus* always present. In the places where pigment was lacking, dense connective tissue was found which contained neither vessels, glands nor microfilaria. In the epidermis, general hyperkeratosis was noticed, often with infiltration of leucocytes in the stratum germinativum and stratum filamentosum. In the lichenized zones, enlarged dome-like papillae were also found. In the regions of prurigo, similar lesions were encountered, sometimes with vesicles which had in places completely destroyed the epidermis. In some areas there was complete absence of pigment and the horny layers were much thinner than usual. In elephantiasis-like lesions, parakeratosis was present, the papillary vessels being much dilated. The sebaceous glands were very few in number and the sweat glands had apparently disappeared. However, in their opinion, craw-craw is not connected with *Onchocerca* infection and they believe the cutaneous lesions are not caused through pruritis but that the embryos of *O. volvulus* themselves create the inflammatory reactions. Laigret [4] has more recently confirmed these observations upon the production of cutaneous lesions in onchocerciasis, characterized by xeroderma and advanced pseudo-ichthyosis due to constant passage of the embryos in the skin.

Macfie and Corson [5] who examined 290 prisoners on the Gold Coast, found that twenty-four had lichenification of the skin and in fifteen of these filariae were present. However, in a further study regarding lichenification and other skin conditions considered to be due to infection with *Onchocerca*, they note that they have observed these lesions in the skin in which no larvae were found and

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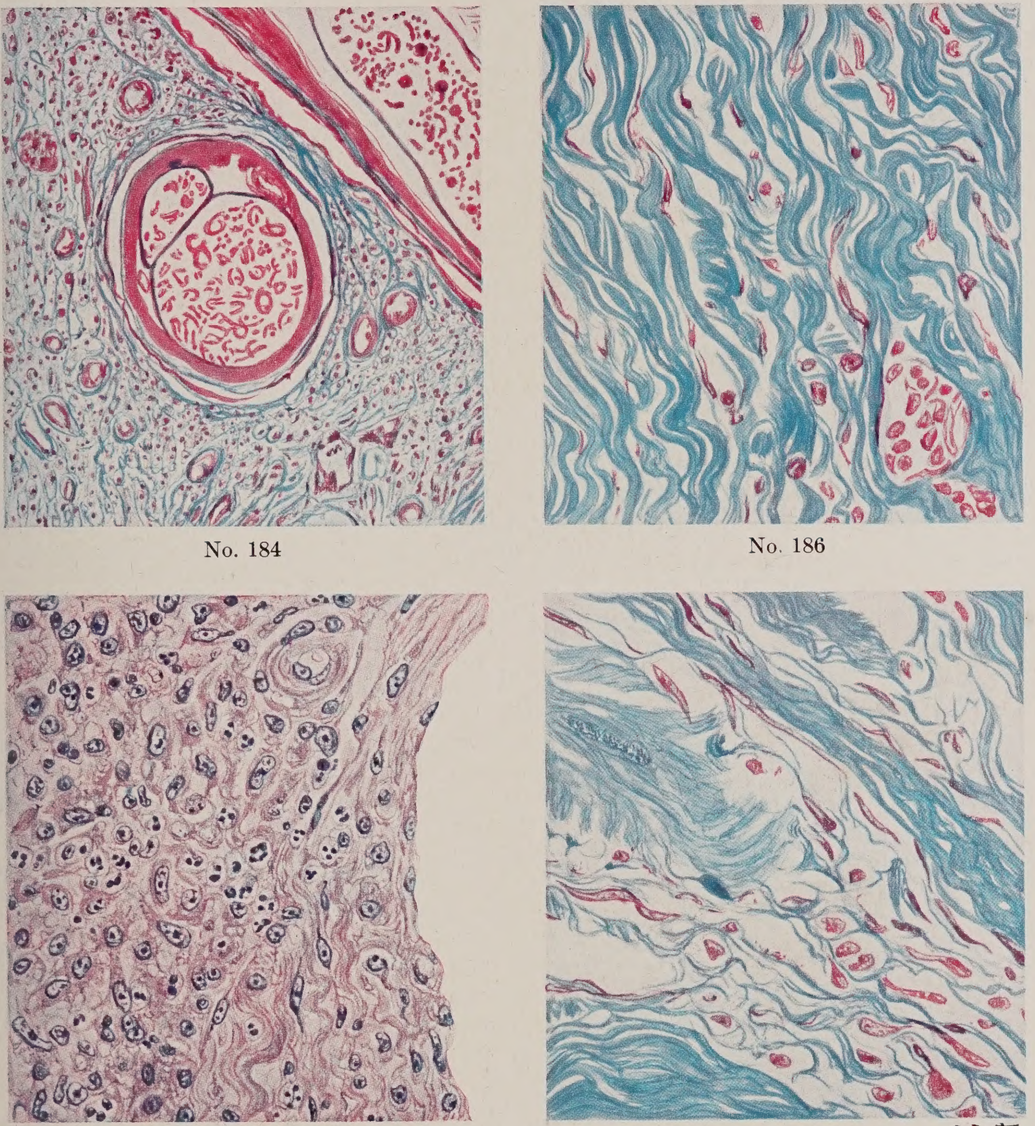
[1] Montpellier, Degouillon, and Lacroix: Bull. Soc. Path. Exot. (1920), XIII, 305, 530.

[2] Montpellier, Lacroix, and Boutin: Bull. Soc. Path. Exot. (1921), XIV, 653.

[3] Ouzilleau, Laigret, and Lefrou: Bull. Soc. Path. Exot. (1921), XIV, 717.

[4] Laigret: Bull. Soc. Path. Exot. (1929), XXII, 499.

[5] Macfie and Corson: Ann. Trop. Med. and Parasit. (1916), XXII, 465.


No. 184

No. 186

No. 185

No. 187

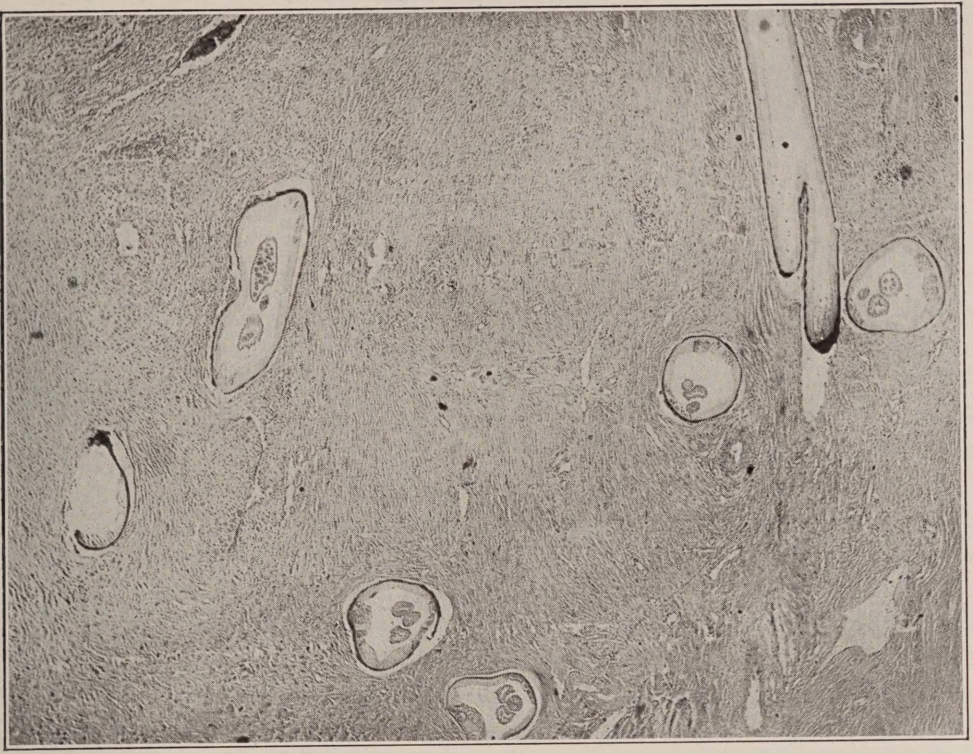
Nos. 184–187. — Camera lucida drawings (Zeiss objective DD, compensating ocular 6)

No. 184. — Drawing of fibromata with sections of *Onchocerca volvulus* cut transversely and longitudinally

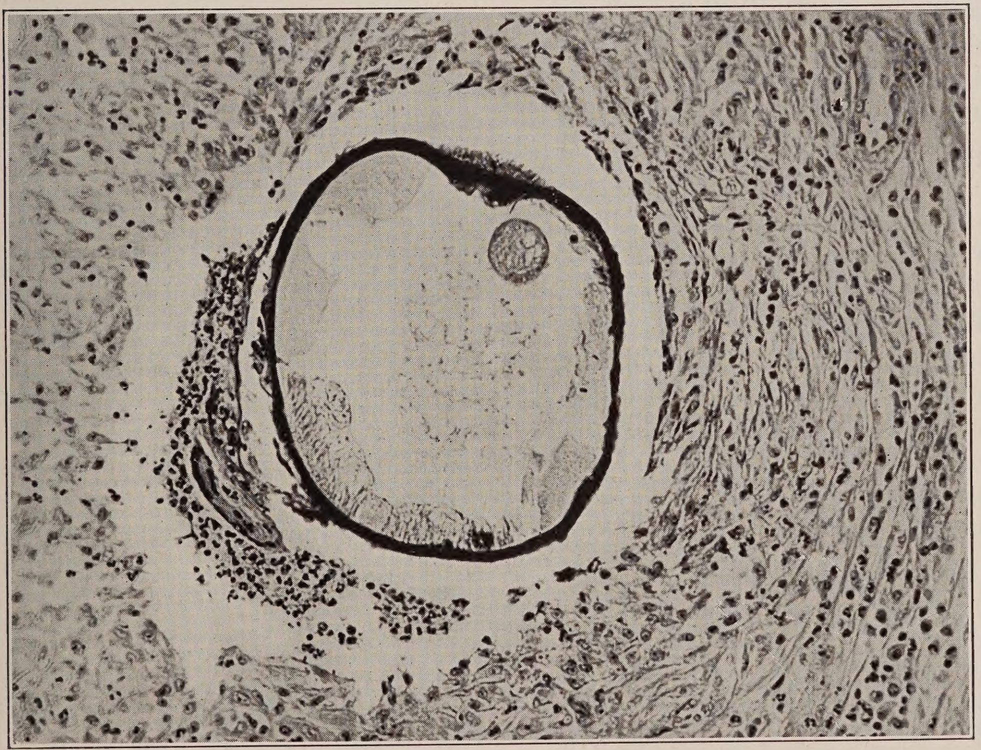
No. 185. — Drawing of cross-section of another tumor produced by *Onchocerca volvulus*

No. 186. — Drawing of section of fibroma caused by *Onchocerca volvulus* showing prevalence of collagen fibrils

No. 187. — Drawing of section of keloid, Case 384



No 188. — Zeiss AA, compensating ocular 6



No. 189. — Zeiss DD, compensating ocular 6

Photomicrographs of sections of fibromata with cross-sections of *Onchocerca volvulus* on the other hand, have observed larvae abundantly present in apparently normal skin.

We also have found the epidermis perfectly normal as far as visible lesions were concerned in some cases in which large numbers of the larval forms of *Onchocerca* were present. Perhaps in certain individuals with great susceptibility to the products of metabolism of these parasites inflammatory changes and scratching of the skin might result. On the present Expedition, the pruritis or craw-craw observed in Liberia in young children was in some instances due to *Sarcoptes scabiei* and in these cases *Onchocerca* was not present in the skin. Hoeppli,[1] in the examination of two cases with *O. volvulus* tumors also concluded that the larval forms of *Onchocerca* do not usually give rise to such lesions of the skin as described by Ouzilleau and Laigret.

Several observers have previously thought that elephantiasis might be produced by *Onchocerca* but this view is not generally accepted. Laigret [2] has reported a case in which there was a volvulus cyst upon the left side of the chest in the axillary line. Upon puncture of this cyst, numerous microfilariae of *O. volvulus* were obtained. There was also elephantiasis of the left foot and beginning on the right foot. Both legs showed greatly dilated varicose vessels. There was no elephantiasis of the genital organs. Upon centrifugation of the blood, however, microfilariae of *F. perstans* were also found, though in rather small numbers.

Sharp [3] says that the larval forms of *Onchocerca* are often present in hydrocele fluid and confirms Ouzilleau in his association of *Onchocerca* with cases of elephantiasis. He believes that the first sign of the disease is not a subcutaneous tumor but the existence of active embryos in and around the corium, and he believes the tumors are only late manifestations of infection. In Nigeria he found skin infection in fifty-five per cent but tumors only in thirty per cent.

Robles [4] called attention in Guatemala to the occurrence of fibromatous nodules upon the scalp, usually about the size of a nut, containing filaria, that were associated with disturbances of the eye, particularly of vision. He emphasized that these disturbances disappear following removal of the tumors, and illustrated his report with photographs of such cases. The cases were observed only in a narrow zone of territory at an altitude of 600–1200 meters. Subsequently Pancheco Luna,[5] Calderón,[6] and Azurdia [7] confirmed these investigations and the favorable results obtained by treatment. Brumpt [8] who studied pathological material furnished by Robles, described the filaria as a new species, calling it *Onchocerca caecutiens*. While it is almost identical with the species *volvulus*, he states that it differs especially in the size and distribution of the papillae in the

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[1] Hoeppli: Beihefte, Arch. f. Schiffs-u. Tropen-Hyg. (1927), XXXI, 251.

[2] Laigret: Bull. Soc. Path. Exot. (1922), XV, 303.

[3] Sharp: Proc. Royal Soc. Med., Section Trop. Dis. and Parasit. (1927), XX, 927.

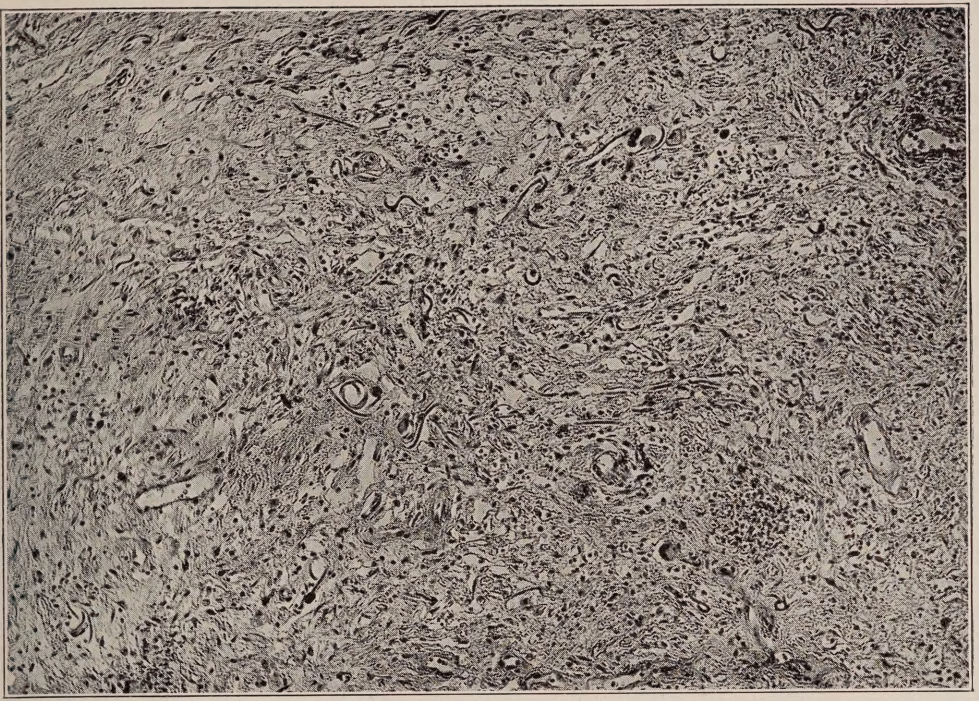
[4] Robles: Bull. Soc. Path. Exot. (1919), XII, 442.

[5] Pancheco Luna: La Juvendud Medica, Guatemala (1921), Jan.–April.

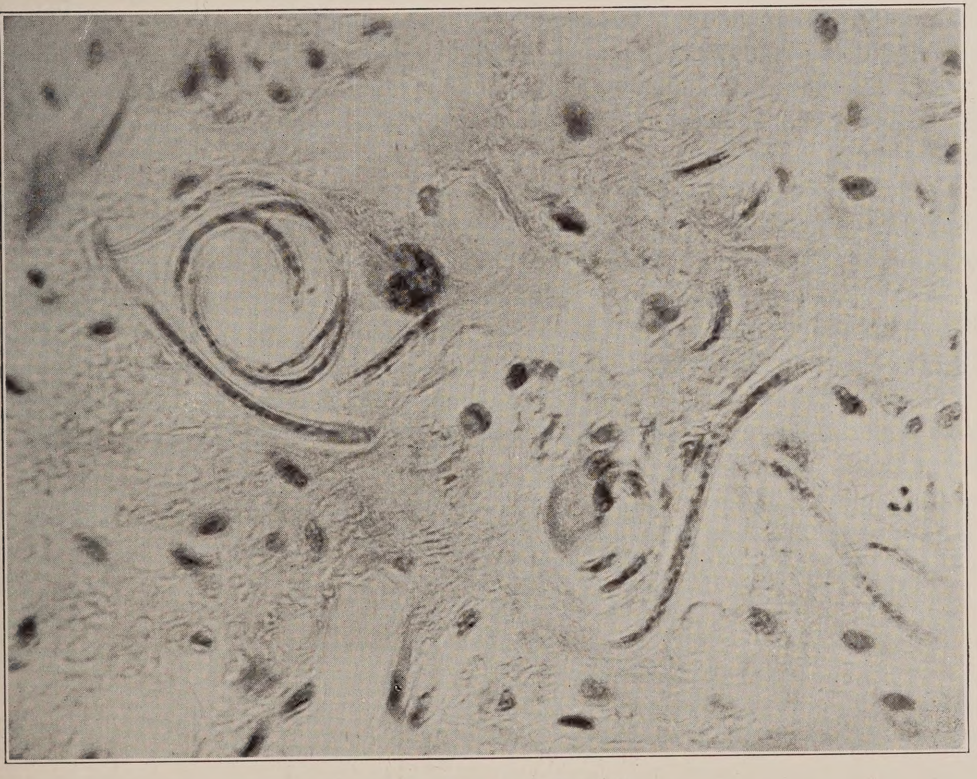
[6] Calderón: Contribución al estudio del Filarido Onchocerca sp. Dr. Robles 1915 y de las enfermedades que produce. Dissertation, Guatemala (1920).

[7] Azurdia: Intern'l Conf. on Health Problems in Trop. America, United Fruit Co. (1924), p. 256.

[8] Brumpt: Bull. Soc. Path. Exot. (1919), XII, 464.



No. 190. — Objective AA, ocular 6



No. 191. — Objective DD, ocular 6

Photomicrographs of sections of fibromata showing numerous larval forms of *Onchocerca volvulus* male, and by the very great size of the spicules. He also emphasizes the fact that in African infection the nodules occur only in about one per cent on the scalp, whereas in Guatemala they are almost invariably so located.

Among the pathological effects of *Onchocerca caecutiens* noted by Robles and the other Guatemalan physicians are photophobia and failure of vision, and iritis, keratitis and conjunctivitis, also the condition known as *Erisipela de la Costa.* The last, according to Robles, is a kind of myxoedema of the skin. It begins with the usual appearances of acute febrile erysipelas but involves in the majority of cases only the face and head. In the chronic stage, a hard elephantiasis oedema of the skin develops which is often eczematous and of a livid greenish color. Fülleborn,[1] who made a brief visit to one of these Guatemala plantations where about seventy per cent of the natives were infected, was not able to confirm these observations with reference to the symptoms and pathological conditions referred to. He found no morphological differences between *Onchocerca volvulus* and *Onchocerca caecutiens,* nor any differences in the anatomical details of the microfilariae of the two parasites. He, however, found the microfilariae of *Onchocerca caecutiens* in the blood taken in the usual manner from the patient's earlobe and in the blood obtained by venipuncture, as well as in the connective tissue of the skin.

Castellani [2] who has also observed this condition in Guatemala at the same time as Fülleborn, says that in his opinion the eye symptoms and coastal erysipelas are connected with the nodules and the *Onchocerca.* Of the eleven cases Castellani saw in Guatemala with Dr. Calderón, all showed in various degrees the eye symptoms already referred to. Castellani was inclined to believe that the two conditions, West African and Guatemalan onchocerciasis, although very similar are not identical.

Larumbe and Hardwicke [3] have recently reported cases of onchocerciasis, "blinding sickness" from Oaxaca, Mexico, with ocular symptoms which were relieved by incision and evacuation of the cyst contents and parasite.

We did not, ourselves, meet with *Onchocerca* tumors about the scalp in Africa, though Brumpt [4] who has had a wide experience with this condition, states that the tumors occur in Africa and in the Congo in one per cent of the cases.

Neither *Simulium damnosum* nor *Onchocerca* tumors are as prevalent in Liberia as they are in certain other parts of Africa; for example, localities in Sierra Leone and the Belgian Congo.

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[1] Fülleborn: Intern'l Conf. on Health Problems in Trop. America, United Fruit Co. (1924), p. 241.

[2] Castellani: Jour. Trop. Med. and Hyg. (1925), XXVIII, 3.

[3] Larumbe and Hardwicke: Trans. Royal Soc. Trop. Med. and Hyg. (1928), XXI, 495.

[4] Brumpt: "Précis de Parasitologie" (1927), p. 757.

XVIII

ONCHOCERCIASIS AND KELOID FORMATION

While there is apparently no doubt that *Onchocerca volvulus* is the primary inciting factor in the formation of the neoplasms in the cases we have studied, one cannot lose sight of the fact that the tendency to the production of keloid growths among many Africans, subject to onchocercal tumors, is very common and marked, and that such growths may follow almost any form of injury or irritant applied to the skin. This fact is made use of by the natives in decorating the skin with various patterns by tattooing or scarifying the skin and sometimes inserting grains of indigo or camwood pigment (No. 47, page 71). Perhaps this tendency to abnormal reproduction of connective tissue following mechanical irritation sometimes may be an additional factor in the production of onchocercal fibromata which occasionally reach several inches in diameter. In Guatemala I have never noticed any special tendency to keloid formation among the natives. The nodules produced by *Onchocerca caecutiens* as we have stated are usually situated about the scalp and generally vary in size from that of a pea up to an almond or walnut. In cattle infected with *Onchocerca gibsoni*, frequently examined in the Philippine Islands, the parasites usually lie encysted in a fibrous capsule and the nodules are also not usually as large as a walnut.

Keloid. The lesions of Case No. 384, a negress about thirty years of age, are illustrated in Nos. 192–193. According to the statement obtained from her by one of us (through an interpreter), the lesions began about seven years ago on the arms, and were produced by magical medicine by a man who wished to kill her. According to the statement obtained by another of us, they followed burns with hot water. Such conflicting statements clearly demonstrate the fact that the medical histories obtained from native Africans are almost invariably worthless as far as authentic information is concerned.

The lesions consist of large keloid-like nodular swellings on the sides of the neck, face, chest, breasts, shoulders, back, arms, legs, and flanks. They are elevated from 0.5 to 1.5 cm. above the surrounding skin and the edges of some of them, particularly upon the back, bulge, and spread out slightly over the underlying skin, so that they have a mushroom-like appearance. The diameter of the tumors varies from about 5 mm. to 15 mm. or more. Some of them have coalesced to form irregular masses. They are all sharply circumscribed but some are circular while others are irregular in outline. Retraction of the swellings in the bend of the elbow has produced a contracture so that the right arm is bent and fixed at an acute angle. The functions of both hands are impaired by scarring and keloid formation on their backs.

Some of the nodules show pitted scars and others more extensive scar formation in the center, but the smaller nodules exhibit little or no scarring. Some of the larger ones are covered by areas of normal skin, while over many of the other swellings, the skin is tense, shiny, and translucent in appearance. The color of the skin is not materially altered, but there is a lack of normal elasticity. The consistency is firm to hard, and some of the large swellings pit very slightly on pressure. A watery secretion exudes from a crevice in one of the swellings and another crevice is crusted. The skin sensation is generally apparently normal. The lymphatic glands are not enlarged. Excision of portion of a nodule from the back caused pain, but one excised from an overhanging edge of another lesion caused no pain. The bleeding was slight.

Pieces of tissue were excised from both the larger and smaller growths, some of the latter appearing to be of more recent origin. On removal and incision of portions of one of the larger tumors, they were found to be of tough consistency and tendinous-white in appearance, while the smaller tumor was of softer consistency and of a pale rose tint upon section. The tissues were hardened in Zenker's solution and in formalin. Film preparations made at the time from the cut section of the nodules showed upon examination that they were rich in cells, and in films stained with Giemsa's solution, on account of the richness in character of the cells, a sarcomatous condition was suggested. In a few of the films, blastomycetic forms were observed in some of the epithelial cells from the surface of the skin. However, the occurrence of *Blastomyces* in superficial layers of the corneal layer is not uncommon in many individuals in parts of Africa not afflicted with keloids. Mention is made of this fact because Legendre [1] and Montel and Pons [2] have reported upon cases of keloid formation where a *Blastomyces* was believed to have had etiological significance.

The sections from the tumors of Case 384 were stained in haematoxylin eosin, Giemsa's solution, Mallory's connective tissue stain, and Levaditi's silver impregnation method. A histological study of the four pieces of tissue removed shows that the lesions which lie beneath the epidermis are composed almost entirely of fibrous connective tissue. However, there are slight variations observed in the different tumors, and also in different parts of the sections of the same tumor. Thus in the larger tumor in places the papillary bodies over large areas have entirely disappeared, whereas in another part of the same section they are retained. In the areas where no evidence of the papillae remains, the epidermis above is not, apparently, altered pathologically. The corneal layer above is not increased in thickness and the stratum lucidum and granular and mucous layers also appear normal. In the basal portion of the mucous layer, pigment is still present in the cells in about normal amount. In the areas where the papillae have entirely disappeared, the stratum mucosum consists of a wide, even, very slightly or broadly-waving band resting directly upon the altered reticular layer in which the connective tissue fibers run more or less parallel to the surface of the skin.

The normal rete is replaced in many areas by coarser bands of fibrous connec-

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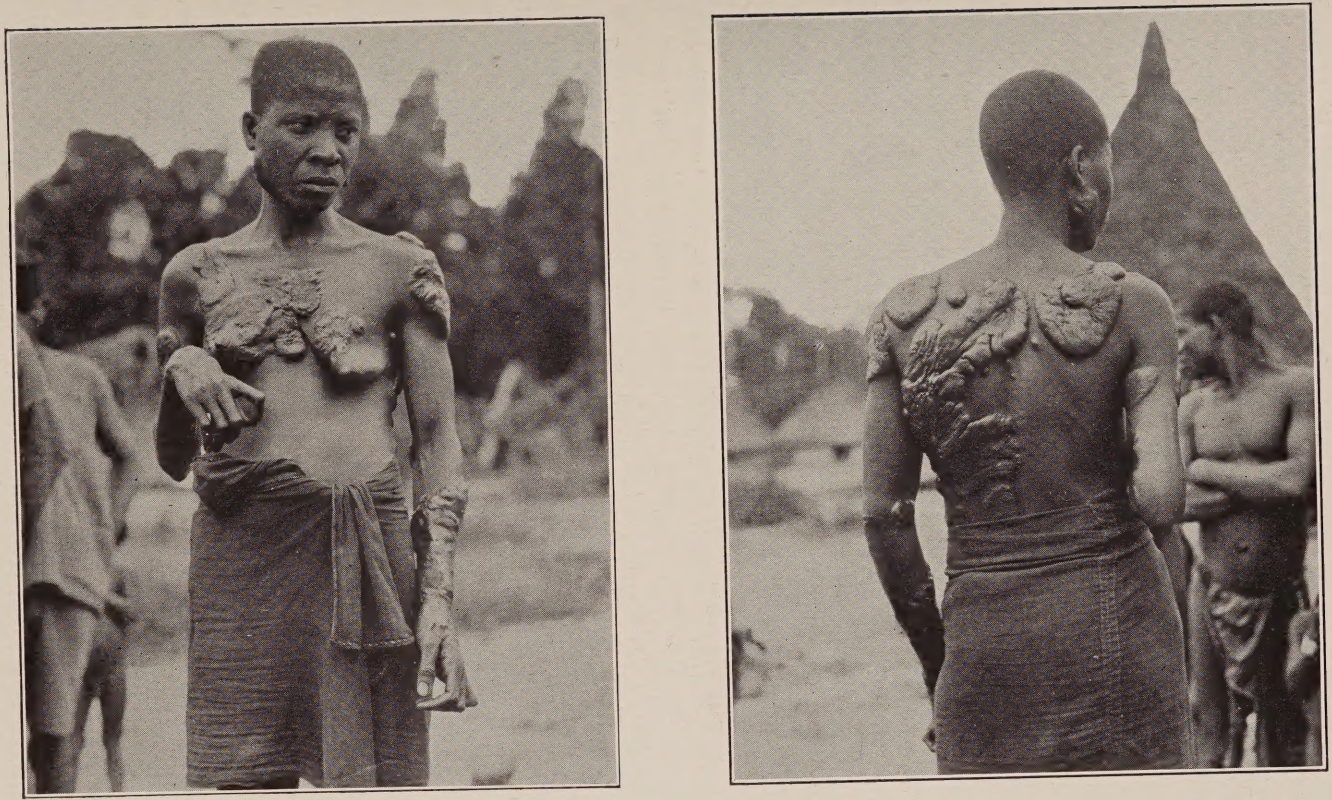
[1] Legendre: Bull. Soc. Path. Exot. (1927), XX, 323.

[2] Montel and Pons: Bull. Soc. Path. Exot. (1926), XIX, 876.



Nos. 192, 193. — Giant keloids, Case 384 tive tissue which extend up to the surface of the stratum mucosum. Some of the waving connective tissue fibers are so thick as to resemble in size microfilariae. No elastic fibers can be distinguished in these areas, which is in marked contrast to what is usually observed in ordinary cutaneous scar tissue. In other places the tissue is rich in long spindle nuclei, and the growth otherwise consists of dense fibrous tissue, while in still other areas the fibroglia fibrils are distributed in thin strands between layers or bands of the coarser collagen fibers. These appearances are especially marked in the sections stained by Mallory's connective tissue stain (No. 187, page 247). There are good numbers of blood vessels within the tumors and in many areas there is slight infiltration and proliferations of the cells about them. However, the proliferation and infiltration is not marked and the infiltration does not extend into the surrounding tissue for any great distance. For the most part, the tumor is strikingly free from infiltration with cells. The proliferation of the fibroblasts is a much more striking feature than the proliferation of the vascular endothelium. On the whole, the tissues show a marked regenerative process on the part of the fibroblasts with little or no endothelial or lymphocytic infiltration.

In places in other sections of the larger tumor the papillae are preserved. In some areas they are fewer in number and in others almost normal in number but considerably flattened and shortened.

In a section from the younger tumor, the papillae are even increased in number or are irregular in distribution, and in places, lengthened. In this section the corium is richer in nuclei, many of which are rounded, others are of spindle form, and arranged longitudinally along the vessels. In still another area of this section, just beneath the basal layer of the stratum mucosum, the entire field of the microscope (with ocular K8 and objective D, Zeiss), is occupied by proliferated cells with rounded or irregular shaped nuclei. Here there are very few connective tissue fibers visible and the appearance suggests sarcomatous changes. Just outside of it, however, the tissue resembles that of a cicatrizing fibrosarcoma. Here there are closely approximated broad bundles of fibers in which spindle-shaped cellular elements are present.

In some of the pieces, particularly of the larger tumors, no sections of hairs and glands are found. In the younger tumor, while in places the epidermis is greatly thinned, and the stratum corneum, and mucosum are represented only by very thin layers of cells, in other portions of the same tumor the epidermis is normal and both hairs and sweat glands are present in the corneum.

Keloid tumors of such extent and size as observed in Case 384 are rare even in Africa.

Van den Branden,[1] who has had excellent opportunities for many years in the Congo for the observation of a large amount of clinical and pathological material, in reporting upon the clinical condition which he illustrates of a very similar case to our own, refers to the great rarity of such extensive keloid lesions.

Gromier [2] has recently reported from New Guinea a case in a woman, aged forty, with extensive generalized keloidal tumors over the trunk and limbs, particularly over the chest and arms, and soft nodules in the lobes of the ears. The skin lesions were said to have commenced as pruriginous nodules at the age of thirteen years.

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[1] Van den Branden: Bull. Soc. Path. Exot. (1917), X, 39.

[2] Gromier: Bull. Soc. Path. Exot. (1927), XX, 553.

The explanation for the marked tendency toward keloid growths among many African tribes is difficult. Sometimes an hereditary predisposition has been observed. Justus [1] believes there is some relationship between hyperthyreosis and keloid formation, while Payr [2] believes that individuals with hypoplastic constitutions are especially predisposed to their formation, in fact to rich connective tissue formation in general, such as the production of adhesions. Menes,[3] however, thinks that scrofula and syphilis predispose to keloids. None of these explanations except hereditary and racial tendencies seem to be particularly applicable to the frequent occurrence of the condition among certain African peoples. Keloids frequently develop at the time of puberty or in the years immediately following.

Ainhum. Ainhum was very prevalent in the interior of Liberia. It might be unilateral or bilateral and occasionally caused the loss of a fourth toe as well as of the fifth. Where the ring-shaped band of fibrous tissue had resulted in such loss the remainder of the foot was not pathologically altered. Stitt [4] points out that this condition is probably connected with a tendency to keloid development. The fact that ainhum often is said to be connected with injuries to the under surface of the toe would favor such a view. Often a fibrous cord has replaced the bony structures normally attaching the toe to the foot. Unna, who has investigated the pathological histology, found a ring-form scleroderma with thickening of the epidermis causing an endarteritis with the production of a rarefying osteitis. Such changes may be secondary to the primary proliferation of the fibrous tissue. Castellani [5] who has observed similar changes to Unna, also points out that the constant irritation causes the epithelium to proliferate internally and depress the skin, and the fibrous connective tissue of the cutis to become increased in quantity. Zambaco [6] believes that ainhum is a manifestation of leprosy. While we did not examine this lesion histologically in the cases of ainhum we observed in Liberia, there was certainly nothing to suggest leprosy in some of them, and no acid-fast bacilli were found in the cases examined.

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[1] Justus: Arch. für Derm. und Syph. (1919), p. 127.

[2] Payr: Arch. für Klinische Chirurgie (1919), p. 116.

[3] Menes: Berl. klin. Woch. (1919), p. 11.

[4] Stitt: "Diagnosis and Treatment of Tropical Disease" (1929), Fifth Edition, p. 486.

[5] Castellani: "Practice of Medicine in the Tropics" (1923), ed. by Byam and Archibald, III, 2438.

[6] Zambaco: Hansen u. Looft, Die Lepra, 1894, p. 1534.

XIX

JUXTA-ARTICULAR NODULES

THE relationship of certain onchocercal tumors to the lesions classed as juxta-articular nodules is of interest. Blacklock [1] says he would have diagnosed several of his cases as juxta-articular nodules but for the fact that they occurred in a region where *Onchocerca volvulus* was present. In one of his cases there were nodules about each trochanter, each elbow, and the left knee. Nine punctures of the nodules were made and amber-colored fluid was usually obtained, but no larvae or ova of filaria. He would have concluded the lesions were not due to *O. volvulus* but for the fact that he later found the embryos of this parasite in sections of skin from the scapula, loin and thigh regions. He notes another similar case, anatomically, with similar findings regarding the parasites. Van Hoof [2] says that *Onchocerca* tumors simulate very well juxta-articular nodules and points out that the filarial nodes affect the same regions. He adds that it is impossible to distinguish clinically one from the other and says in order to do this it is necessary to resort to puncture and microscopical examination of the fluid removed. However, as Blacklock has shown, and we have also had similar experience, this does not always lead to the determination of the etiology. Dubois [3] points out that onchocercal tumors may cause confusion with other juxta-articular tumors. As we shall illustrate, however, the histological picture of the nodules due to *Onchocerca* is quite different from that of juxta-articular nodules.

Sharp [4] points out that onchocercal tumors may simulate juxta-articular nodules, which latter condition he declines to believe forms a clinical entity and regards as a sequela of a fibrous tumor caused by *Onchocerca,* spirochaetes or other organisms as the result of slight but prolonged irritation to the subcutaneous fascia.

We also encountered in Liberia and the Belgian Congo, a number of cases answering to the clinical description of juxta-articular nodules. In all, ten cases were studied. In a number of these we were likewise unable to demonstrate the embryos of *Onchocerca volvulus* by aspiration or sections of the skin. In one, however, we found this parasite (Case 498, Illustration No. 182). Of course it is quite possible in some instances after the nodule is in process of formation that the adult filaria might die within the nodule and disintegrate or even perhaps withdraw from it. In Photograph No. 194 one of the typical cases of juxta-articular nodules observed in Liberia (Case 75), is illustrated. The patient was

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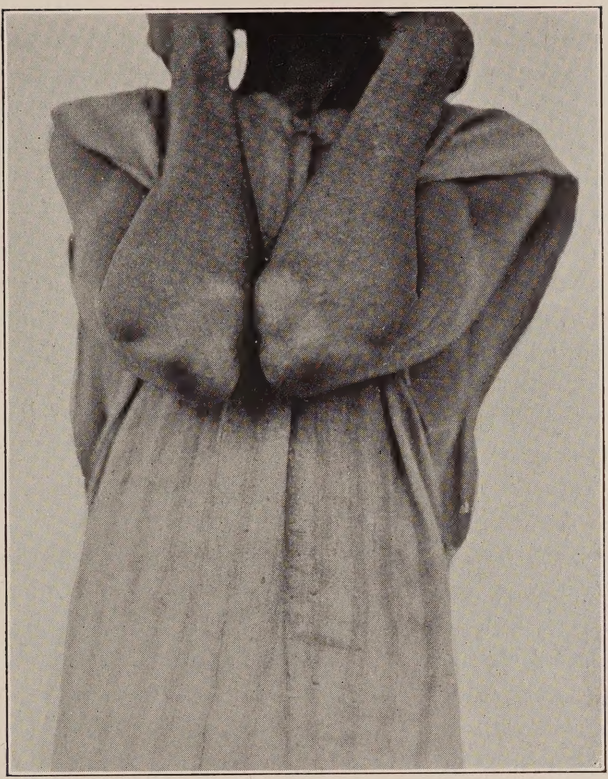
[1] Blacklock: *Loc. cit.*

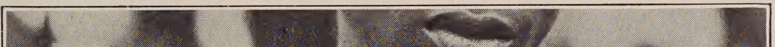
[2] Van Hoof: Ann. Soc. Belge de Méd. Trop. (1926), VI, 53.

[3] Dubois: Bruxelles Méd. (1925), V, 1453.

[4] Sharp: Proc. Royal Soc. Med. (1927), XX, 927.



No. 194. — Case 75



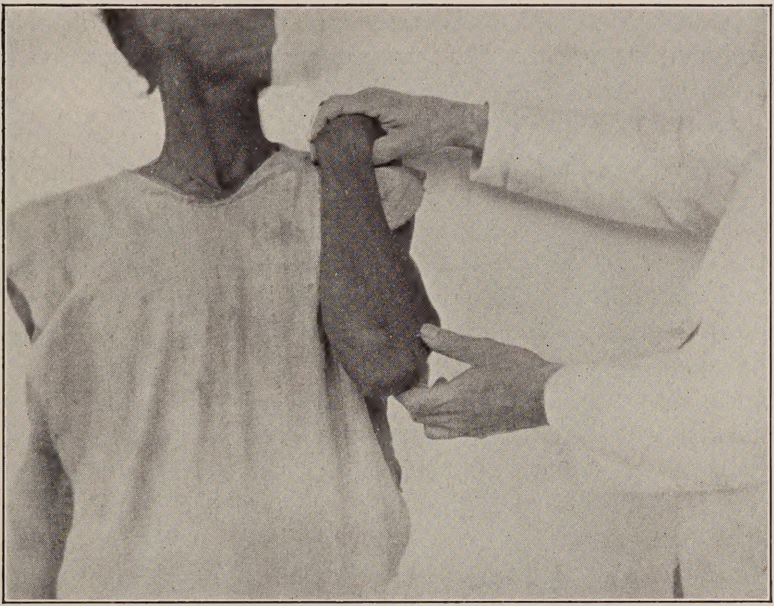
No. 195. — Case 221
Juxta-articular nodules

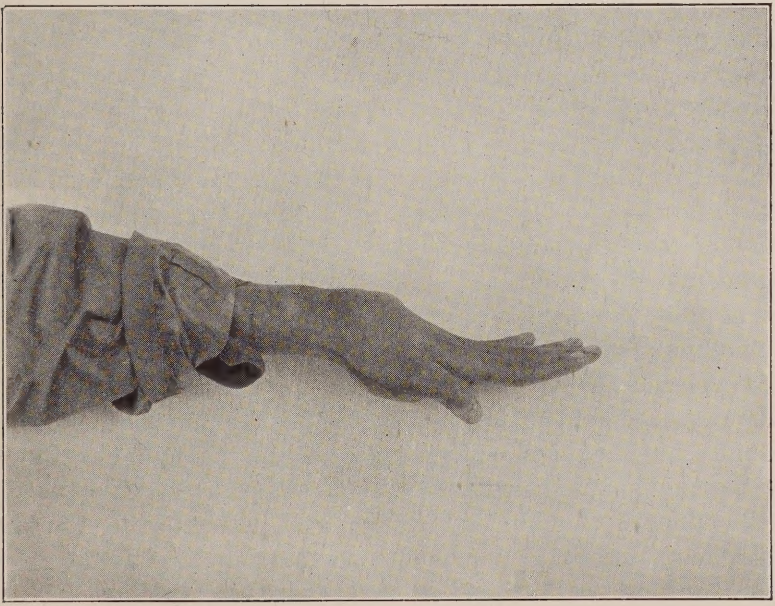
one of the Gibi tribe, of a low degree of intelligence, and no satisfactory history of the condition could be obtained. There were two tumors, 6 and 7.5 cm. in diameter, on both elbows, 2.5 cm. in height. These were kindly removed for us by Dr. Willis. The nodules were fibroid in character and on cut section were seen to consist of fibrous tissue in which there were circular harder areas, whitish in color, containing in turn less homogenous pale yellow areas. In the center of the yellowish areas, apparently some necrosis of the tissue had occurred. No spirochaetes or parasites were seen in the tumors by darkfield examination, or in film preparations stained in Giemsa's solution. The latter specimens showed many large swollen endothelioid cells with phagocytized nuclei and cells. Cultures in spirochaetal media and on agar remained sterile.

Another case, No. 221, is illustrated in No. 195. The patient was a young man of the Kpwesi tribe who stated that the nodules were first noticed about two years ago. There were several soft nodules on the back of the left hand, on both sides of the wrist, and one just below the elbow. The right wrist was similarly affected, but the growth was not so prominent and there was a nodule on the dorsum of the foot. The nodules were firmly adherent to the underlying structures, but not to the skin. The skin over the nodules, showed no visible pathological changes. Two of the nodules, one on the elbow and the other on the wrist, were punctured and a small amount of yellowish fluid withdrawn from which cultures and film preparations were made.

The fresh film specimen of the fluid, when examined microscopically was very rich in cells. Many leucocytes and a few red blood corpuscles were present, but no spirochaetes or bacteria or parasites were found, the specimen also being examined by darkfield. After centrifuging the small amount of fluid obtained, stained preparations with Giemsa's solution were made from the sediment. These showed many large endothelial cells and polymorphonuclear leucocytes. Many of the endothelial cells contained phagocytized nuclei and polymorphonuclear leucocytes. No bacteria or other organisms were observed. Portions of the nodules about the elbow and later from the foot were excised and pieces placed in Zenker's solution and formalin. Cultures were also made from the cut surface of the nodule on the foot just before its removal. Film preparations made from these tumors did not reveal either bacteria or parasites. All the cultures made on ordinary laboratory media and Sabourraud's media were examined microscopically after a week and still remained sterile. No filariae were found in any of the preparations. Five days after removal of these tumors another nodule was removed and also hardened. The stained film made from the cut surface of this tumor showed strands of fibrin, many endothelial cells, occasional leucocytes, and a few fibroblasts and very large epithelioid (?) cells. No parasites or inclusions suggestive of parasites were found in the cells. The nodules in this case were evidently closely associated with the tendons or joints and to some of the lesions, particularly on the back of the wrist, it was noted in the clinical description that the term "ganglion" might better be applied.

We also found no spirochaetes and were able to cultivate no organisms from the other cases of juxta-articular nodules that we studied. Cultures from fluid



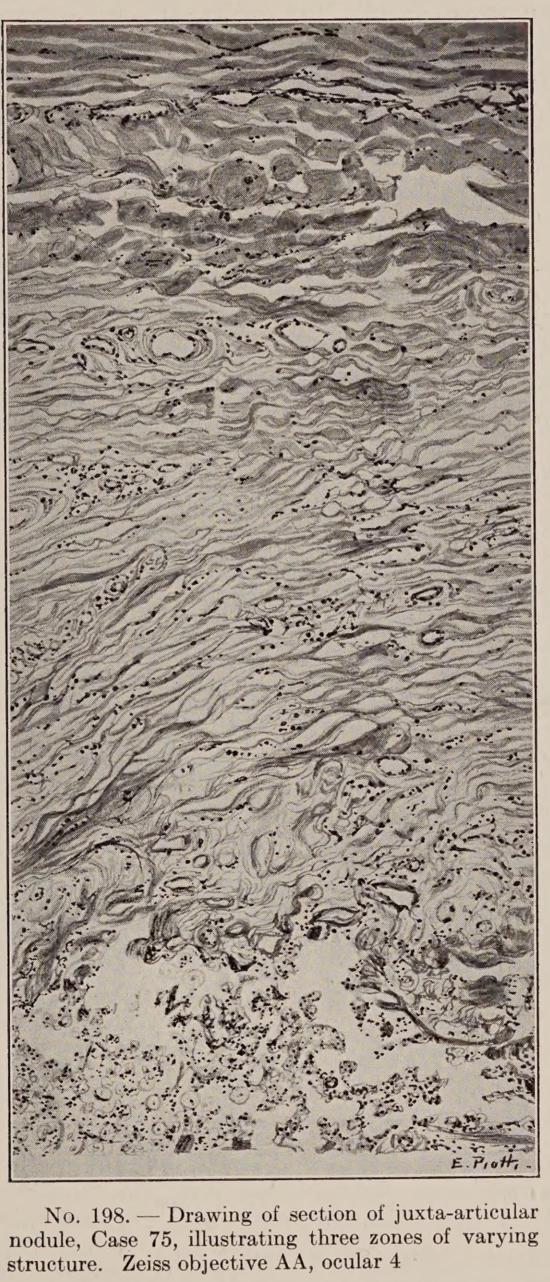


Nos. 196, 197. — Juxta-articular nodules, Case 76 withdrawn in four of our cases also remained sterile, and no micro-organisms of any nature could be detected on microscopical examination. In only one case, No. 498 (excluded from this series), were onchocercal embryos and adult parasites demonstrated.

The number of leucocytes in the serum of fluid removed from the other juxta-articular tumors varied greatly. In one case there were very large numbers of polymorphonuclear leucocytes, but no bacteria were present. Large, greatly swollen endothelial cells containing phagocytized cells and nuclei were observed in four of the cases. Tissues from the different cases were hardened in Zenker's solution and in formalin and stained by Levaditi's silver impregnation method, Giemsa's stain, Ziehl-Neelsen's method, carbolfuchsin, and methylene blue, and eosin and haematoxylin and eosin and Vierhoff's stain.

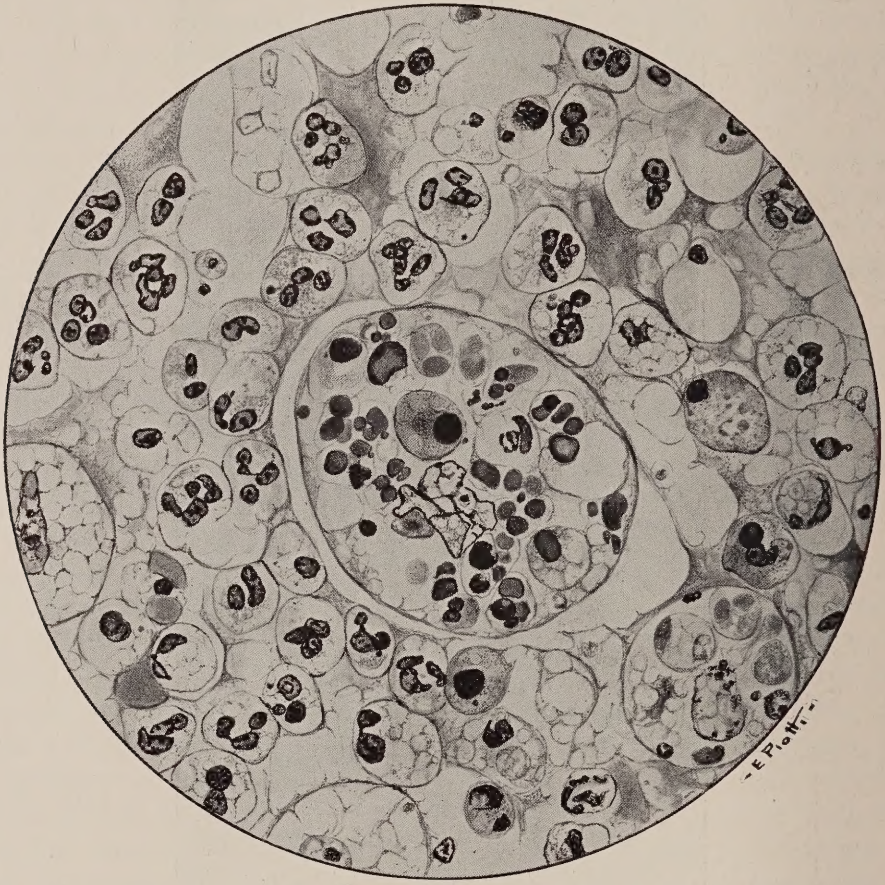
Histological study of the sections of the juxta-articular nodules removed from our cases show in general near the center of the nodule, a necrotic area or areas in which there are many polymorphonuclear leucocytes, phagocytes and, especially, large swollen cells resembling foam or lipoid cells, often containing large numbers of phagocytized cells or chromatin particles. There are also in some areas the usual endothelial cells and a few small round cells. In these necrotic areas, no bacteria or parasites are visible. Outside such areas of more acute inflammation, which almost resemble abscesses save for the absence of purulent exudate, is a zone in which round cells, plasma cells, and fibroblasts are usually visible in varying numbers. Still further toward the periphery the nodule is composed of very dense fibrous tissue in which no elastic fibers are observed. The skin over the tumors is practically normal in appearance. We have not been able to demonstrate any definite spirochaetes in the sections stained by Levaditi's method or by Giemsa's solution and no acid-fast bacilli were found in sections stained by the Ziehl-Neelsen method. A better idea of the complete histological picture can be obtained from a review of the examination (with illustrations) of one of the cases (Case 75, Nos. 194, 198, and 199). The epidermis and upper layers of the corium are not pathologically changed, with the exception that the corneal layer is somewhat thickened. The peripheral zone of the nodule consists of very dense fibrous connective tissue in which there are very few vessels. This tissue is generally not rich in nuclei, but as one approaches the center, one finds areas in which the fibroblasts are proliferating and the nuclei more numerous. In other areas nearer the center of the nodule the connective tissue is richly vascularized. The vessel walls are slightly thickened and there is evidence of early endarteritis and peri-arteritis, the proliferating endothelial cells extending in places into the surrounding tissue. Some of the blood vessels show all coats of the arteries moderately thickened.

As one approaches still nearer to the center of the lesion, one finds the connective tissue fibers pushed apart, and there are spaces in which large numbers of polymorphonuclear and endothelial leucocytes are present. In other areas there are yellow masses or clumps of altered blood pigment. Finally, in the center, one finds large areas of necrosis with openings in the fibrous tissue occupied only by polymorphonuclear leucocytes and by swollen vesicular, foam-like



No. 198. — Drawing of section of juxta-articular nodule, Case 75, illustrating three zones of varying structure. Zeiss objective AA, ocular 4

cells. These large cells constitute the dominating picture in the areas of necrosis. They are thin-walled, have a lipoid appearance with a large, usually irregularly shaped, lightly-staining nucleus (No. 199). The cells are round or oval and show some reticular markings. Some of them measure up to 80μ in their greatest length, though they vary greatly in size. At times these cells are devoid of inclusions or chromatin except the nucleus. More commonly they contain polynuclear leucocytes or rounded masses of chromatin. In some instances between forty and fifty small masses of chromatin, at least 3–4μ in diameter, may be observed by actual count in single cells. These particles of chromatin are apparently often the nuclei of included cells, about which the protoplasm has disappeared. In other instances the included leucocyte with its nucleus can be distinguished. These large cells resemble somewhat those described as xanthoma cells or, according to other authorities, they follow the descriptions of swollen clasmatocytes or histocytes. Some of them show slight fibrils at the ends, suggesting that they are epithelioid cells and that they are of connective tissue origin. Whether they are overgrown fibroblasts or overgrown lymph



No. 199. — Center of nodule of Case 75. Zeiss objective 2 mm., ocular 10x

vessel endothelial cells, both infiltrated by lipoids, cannot be stated. They, however, are macrophages and according to some authorities the macrophages are particularly cells of the connective tissue belonging to the reticulo-endothelial apparatus. From the study of this tissue nothing more definite can be added in regard to the controversial question of the origin of such cells.[1]

Near the edges of these abscess-like areas and sometimes within them there are islands of fibrous tissue which take on a deep pink stain with eosin and contain no nuclei whatever. It is about these areas that the cellular proliferation and infiltration just described is also observed, as well as in the center of the nodules where it alone is present.

MacGregor apparently first observed these nodules in natives of New Guinea and suggested a parasitic origin for them.

Jeanselme [2] in 1899 first applied the name "nodosités juxta-articulaires" to these lesions, and described them clinically as nodules of various sizes, globular or polyglobular, often collected in groups or masses. The tumors were situated deep in the subcutaneous tissue, some being movable and rolling under the fingers like ganglia. Others appeared adherent to the periosteum, in which some originated. As the nodules enlarged they became more superficial and were sometimes incorporated in the skin. Later still they rose above the surface as protuberances of very hard consistency. The skin underwent no modification, being only distended and sometimes changed in color at the most prominent point. It was also noted that the nodules were remarkably symmetrical and tended to occupy the external aspect of the extremities, surmounting by preference the bony prominences and grouping about the joints. The points of predilection given on the lower extremities were the external malleolus, head of the tibia, tubercle of the tibia, anterior surface of the knee, trochanteric and sacrococcygeal regions, on the upper extremity the olecranon, epitrochlea, acromion, and dorsal surface of the digits.

Jeanselme at first inclined to ascribe as a cause of these nodules the habits of the natives who lie with the elbows and knees in contact with the ground. His bacteriological examination was completely negative and he states that in sections stained by Ziehl or Gram, or after treatment with forty per cent potassium hydroxide, he had never demonstrated any microbes. Histological examination made first with low magnification showed that the lesions were divided into three zones; an internal or zone of degeneration; an external or inflammatory; and an intermediate, or zone of transition. The degenerative zone contained areas homogeneous and translucent which stained a deep red with eosin. In the spaces between these areas, polymorphonuclear cells were seen undergoing disintegration. The numbers of leucocytes increased as one approached the periphery of the degenerated areas. The leucocytes were situated particularly in the large, otherwise empty spaces, sharply circumscribed in the dense fibrous tissue. The inflammatory areas showed two very different appearances; one in which fibrous tissue predominated and the other of yellow, more softened tissue. In the latter were found large and anastomozing thick cells in the reticulum. Here some of the thick cells were free in the form of macrophagocytes. There were also some giant cells and innumerable plasma cells in the interstitial spaces, also large numbers of polynuclear cells and some eosinophils. Finally there were numerous blood and lymph capillaries which consisted of only one layer of flattened or raised epithelial cells. Between the inflammatory zone in the interior and that of sclerosis, there existed transitional appearances. The collagen elements in the latter gradually predominated over the cellular, and the fibroblasts disposed themselves in thick bundles separated by interstices and forming a mosaic of fixed flattened cells. Between the more central focus of necrosis and the inflammatory area there occurred changes which gradually caused the degenerative tissue to act as a foreign body within the fully sclerosed tissue. Jeanselme further points out that the microscopic examination revealed nothing as to the nature of the nodule. To him they certainly did not reveal evidence of syphilis or tuberculosis, nor any suggestion of xanthoma, all of which have characteristic structures. With reference to their origin, he considered the possibility of tophi, but concluded against such an idea. He points out that the nodules are not fibromata nor sclerosed forms of peri-articular bursae. It has seemed of importance to give at some length, Jeanselme's ideas about this condition which he originally described in this manner.

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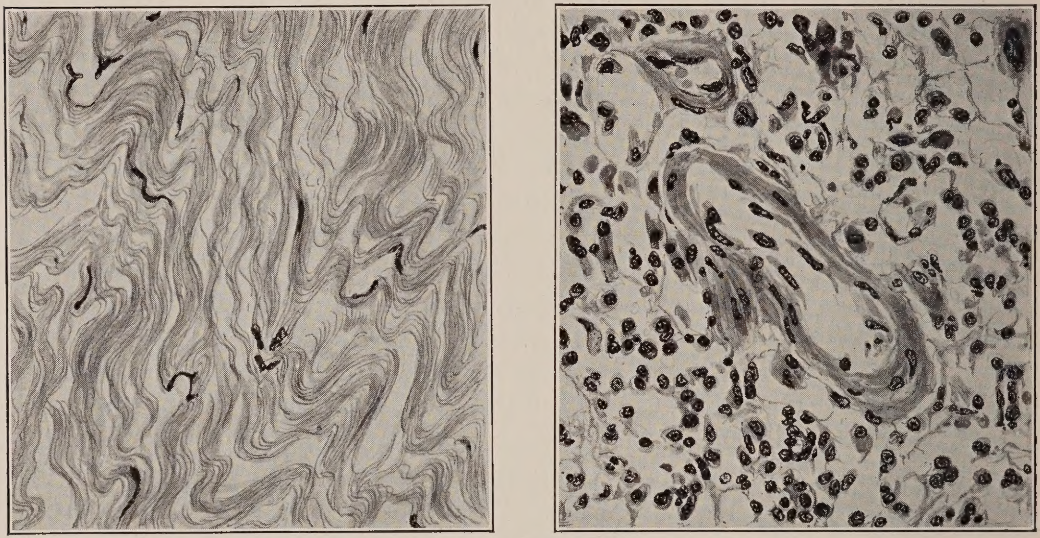
[1] Wright (Amer. Jour. Path. (1930), VI, 87) has contributed a valuable discussion upon the origin of endothelial leucocytes and monocytes.

[2] Jeanselme: Soc. Méd. Hyg. Trop. (Dec., 1910); "Précis de Pathologie Exotique," Paris (1909), p. 734. Ann. de Derm. et Syph. (1901), II, 833.



No. 200. — Section of periphery of nodule.
Objective D and compensating ocular 4

No. 201. — Section nearer center of nodule.
Objective D and compensating ocular 4

Juxta-articular nodules, Case 221

From the more recent literature upon the subject, juxta-articular nodules have usually been generally regarded as any subcutaneous tumors, freely movable, of firm consistency, and situated in the neighborhood of the joints, particularly about the trochanter, olecranon and lower end of the femur, not adherent to periosteum or skin. However, Steiner [1] points out that nodules may also grow elsewhere than in the neighborhood of joints.

Mendelson [2] who has suggested the term xanthom tropicum for juxta-articular nodules, has described them as hard fibromata in which various degenerative changes, amyloid, etc., have been observed.

Takasaki [3] also describes these lesions under the name xanthoma tropica and regards them as inflamed fibromata.

In regard to the aetiology, some of the earlier writers thought they were of parasitic origin, and Fontoynont and Carougeau [4] recorded that a fungus, later designated a *Nocardia,* (which Brumpt named *Nocardia Carougeaui*), was present in some cases. Mayer [5] reports that he observed in one case short threads of fungi which, however, he was unable to cultivate. Others have believed they were syphilitic in origin. More recently it has been suggested that they are a tertiary manifestation of yaws. Bernard and Broden [6] have shown that the geographical distribution of yaws and of juxta-articular nodules is very much the same, and they incline to the view that at least generally the nodules represent tertiary lesions of yaws, though not invariably. Mouchet and Dubois,[7] Van Hoof,[8] Spittel [9] and Bittner [10] are among those who also take this view.

MacGregor [11] has recently reported fifty cases of ganglion about the wrist with positive Sachs-Georgi reactions and found that in two cases juxta-articular nodules were also associated. No signs of yaws were present, but he considers the lesions to be a manifestation of that disease.

Gutierrez [12] in Manila, found that sixteen of twenty cases gave a positive Wassermann reaction. In the majority of these a history of yaws from five to ten years previously was obtained. Egyedi [13] who says that eight per cent of the Nias on an island near Sumatra suffer from yaws but that syphilis is unknown there, also believes juxta-articular nodules are due to yaws.

Some recent investigators besides ourselves have failed to find spirochaetes in the nodules. Notably among these are Jeanselme, Burnier, and Eliascheff,[14] Joyeux,[15] Goodman and Young,[16] Montenegro,[17] Mendelson,[18] Jessner,[19] Akovbian[1] and Aramaki.[2] However, Van Dijke[3] of the Dutch Indies, and Sobernheim[4] in Berne, and Clapier[5] in Africa, as well as Van Hoof,[6] have all reported the presence of spirochaetes, each in one instance. In Clapier's case, the spirochaetes were obtained from a suppurating lesion. Van Dijke and Oudendal[7] also observed spirochaetes with the dark field and by using Levaditi's silver impregnation method, and they state they invariably succeeded in demonstrating the presence of spirochaetes in the tissue. They were unable to decide whether these organisms related to syphilis or to yaws. While the histological changes they describe agree very well with those observed by us in the material from our own cases, they publish drawings illustrating both spirochaetes and elastic fibers in their sections and we found no spirochaetes in the lesions of our cases. They also describe and illustrate different giant cells in the "inner zone."

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[1] Steiner: Schweiz. Med. Woch. (1927), LVII, 395.

[2] Mendelson: Jour. Trop. Med. and Hyg. (1923), XXVIII, 181.

[3] Takasaki: Acta Dermatologica (1924), IV, 219.

[4] Fontoynont and Carougeau: Arch. Parasit. (1908–1909), XIII, 583.

[5] Mayer: "Exotische Krankheiten," Berlin (1929), p. 346.

[6] Bernard and Broden: Ann. Soc. Belge Méd. Trop. (1925), V, 25. (Trop. Dis. Bull. June, 1926, XXIII, 454); Bruxelles Méd. (1925), V, 1144.

[7] Mouchet and Dubois: Bull. Soc. Path. Exot. (1913), VI, 14. (Trop. Dis. Bull. Mar. 1913, p. 530); Dubois: Bruxelles Méd. (1925), V, 1453.

[8] Van Hoof: Ann. Soc. Belge Méd. Trop. (1926) VI, 53.

[9] Spittel: "Framboesia Tropica" (Parangi of Ceylon, London, 1923).

[10] Bittner: Amer. Jour. Trop. Med. (1926), VI, 123.

[11] MacGregor: West Africa Med. Jour. (1927), I, 6.

[12] Gutierrez: Arch. Der. and Syph. (1925), XII, 159.

[13] Egyedi: Meded. Dienst d. Volksgezondheid in Nederl-Indie (1925), p. 175.

[14] Jeanselme: Bull. Soc. Path. Exot. (1916), IX, 287; Jeanselme, Burnier, and Eliascheff: Bull. Soc. Française Dermat. et Syph. (1928), No. 6, p. 450.

[15] Joyeux: *Ibid.* p. 290.

[16] Goodman and Young: Amer. Jour. Med. Sci. (1920), CLIX, 231.

[17] Montenegro: Brazil Med. (1923), I, 233.

[18] Mendelson: *Loc. cit.*

[19] Jessner: Arch. f. Derm. und Syph. (1926), CLII, 132.

A few cases of juxta-articular nodules have been found in individuals who have not been outside of Europe and at least one not outside the United States. Nevertheless, the disease is said to be rare in white people and only about twenty-five cases in the white race have been reported.

Webber,[8] Goodman and Young,[9] and Worster-Drought[10] have reported somewhat similar lesions, under the name subcutaneous fibroid syphilomas, and Patane,[11] Akovbian,[12] Da Fonseca,[13] and Jessner[14] have observed juxta-articular nodules in cases of late syphilis. Araujo[15] says that he has found no cases associated with yaws but has observed sixty cases in syphilitics. Jessner in a study of the literature accepts sixty-two cases of juxta-articular nodules in which he believes yaws can be excluded as a cause. Twenty of these were from Europe and North America and forty-two from North Africa, including three cases of his own. He not only found no spirochaetes in the lesions but rabbit inoculations proved negative. Mendelssohn was unable to infect monkeys with material from the nodule.

On the other hand, other recent observers besides Mendelssohn report neither the association of yaws nor of syphilis. Among these are Kadaner[16] and Aramaki.[17] The latter points out that no cases of juxta-articular nodules have been seen in Japanese who had never left their own country, with the exception of the one case he reports. Fourteen previous cases in Japanese had been reported from Palau Island. In Aramaki's case there was no history of syphilis or yaws and the Wassermann reaction was negative. Joyeux [1] and Jeanselme [2] have also excluded yaws and syphilis in the cases they recently have reported.

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[1] Akovbian: Pensée Méd. d'Usbekistane. Tashkent (1927), No. 8, p. 30.

[2] Aramaki: Japanese Jour. Derm. and Urol. (1928), XXVIII, 58.

[3] Van Dijke: Reports Dutch-Indian Med. Civ. Ser. (1923), pp. 2, 142.

[4] Sobernheim: Arch. f. Schiffs-u. Tropen-Hyg. (1924), XXVIII, 73.

[5] Clapier: Bull. Soc. Path. Exot. (1923), XVI, 553.

[6] Van Hoof: *Loc. cit.*

[7] Van Dijke and Oudendal: Geneesk. Tijdsch. v. Nederl. Indie (1922) LXII, 413, and Reports of the Dutch-Indian Medical Service (1923), Part II.

[8] Webber: Brit. Jour. Derm. (1920), XXXII, 173.

[9] Goodman and Young: *Loc. cit.*

[10] Worster-Drought: Lancet (1926), p. 637.

[11] Patane: Arch. Ital. Sci. Med. Colon. Tripoli (1927), VIII, 20. (Trop. Dis. Bull., Jan. 1928, p. 8.)

[12] Akovbian: *Loc. cit.*

[13] Da Fonseca: Bol. Inst. Brasileiros de Sci. (1927), II, 365.

[14] Jessner: *Loc. cit.*

[15] Araujo: Bull. Soc. Path. Exot. (1928), XXI, 387.

[16] Kadaner: Ann. Soc. Belge de Méd. Trop. (1928), VIII, 57.

[17] Aramaki: *Loc. cit.*

Jeanselme apparently has not appreciably modified his position with reference to his views of these lesions as originally described. The description of the pathological histological changes we have observed, given on page 262 on the whole, is generally in accord with Jeanselme and Eliascheff's [3] observations outlined in their last publications upon the histological examination of cases of juxta-articular nodules. In one of these cases the node was described by them as composed of irregularly disposed bundles of fibrous tissue, poorly vascularized and without any elastic fibers, enclosing a central area of necrosed amorphous tissue. A few polymorphonuclear cells were noted and at the periphery of the amorphous zones there were large polygonal endothelial-like cells which were in reality swollen connective tissue cells, inclosing numerous nuclei, but there was no lymphoid infiltration, no endarteritis and no thrombophlebitis.

In another case, three zones were distinguished; an outer zone of young connective tissue, in places richly vascularized and in which the medium-sized vessels showed endothelial proliferation and thickening of the walls with some perivascular leucocytic infiltration, but no plasmocytes. In the middle zone was found rather denser connective tissue, with fewer collections of cells and the characteristic large swollen endothelioid cells were also present in this case. The innermost zone consisted of homogeneous necrotic tissue showing vessels completely obliterated by endarterial proliferation.

In another case the node was found to consist of fibrous tissue which also in the center showed necrotic changes. About the upper border of the necrotic zones, pseudo-giant cells were noted, but no lymphoid cells. There was no evidence that the process originated about the blood vessels and neither endarteritis or thrombophlebitis was present such as, they remark, is seen in syphilitic lesions. No spirochaetes or other organisms were demonstrated in the tissues. In a case reported by Jeanselme, Burnier, and Eliascheff [4] of a single nodule on the ulnar crest, just below the olecranon, there was no history of infection with syphilis nor of yaws, but the Wassermann reaction was positive and the patient had suffered with some symptoms which might possibly have been of syphilitic origin.

Quite a different histological picture is described by Goodman and Young in their excellent clinical pathological study of a case resembling juxta-articular nodules. They found microscopically that the tissue of the tendon was interspersed with larger and smaller accumulations of round cells. These aggregations were about the blood vessels which were unusually numerous and indicated that new blood vessels and capillaries had formed in the tendon, which is ordinarily almost free of blood vessels. The type of cell predominating in the periarterial gummata was the round cell with occasional spindle-shaped epithelial cells. There were no giant cells nor polynuclears. There was no evidence of caseation or necrosis. No cartilage nor bone had formed. The blood vessels were extremely numerous for a tendon. The majority were of the single layer capillary form. The lumen of even the smallest was open and the lining appeared uninjured. No vessel was seen of sufficient size to show evidence of the infiltration of the coats. There was no formation of a fibrous connective tissue wall about the mass. It was apparently a diffuse process. The histopathological diagnosis was "granuloma, probably syphilitic."

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[1] Joyeux: *Loc. cit.*

[2] Jeanselme: *Loc. cit.*

[3] Jeanselme and Eliascheff: Bull. Mém. Soc. Méd. Hôpit. de Paris (1926), L, 1404; Schweiz. Med. Woch. (1927), LVII, 25.

[4] Jeanselme, Burnier, and Eliascheff: Bull. Soc. Française Derm. et Syph. (1928), No. 6, p. 450.

A study of the other literature upon the subject of juxta-articular nodules also reveals the fact that in a great many of the cases the histological changes are very varied and that the histological picture described by different authors is not uniform.

It is also not clear that the differences, in the various publications regarding the histological changes, can be explained according to the duration of the lesion in different cases. Jessner's description of the lesions he observed, when compared with some other published reports, especially emphasizes this fact. There is, however, a similarity in the histological picture that he describes to that observed by Jeanselme and ourselves. Jessner also found xanthoma-like cells in the inflammatory areas in the lesion he examined and demonstrated the presence of cholesterin by chemical reactions. He considered this lesion to be of syphilitic origin and points out that this is the first time cholesterin has been found in such a case, though it is well known to occur in other cases of tropical juxta-articular nodules.

In many of the cases reported by other investigators, the tumors have not been removed, cultures not made and the lesions not studied histologically, so that they are not of special value from the standpoint of aetiology. Nevertheless, from a study of all the material available, certain features regarding the aetiology of these nodules appear to have been established.

It is quite obvious that juxta-articular nodules often result about localities which are frequently subjected to pressure and to light blows or bruises often repeated. It also seems not unlikely that under certain conditions, they may result from different forms of mechanical irritation, just as other true neoplasms may, and that in some instances they may be onchocercal in origin and in others framboesial or syphilitic. In the last instance, syphilis or yaws may act as a predisposing factor among people or races with especial tendency or diathesis to the abnormal proliferation of fibrous tissue. However, it is difficult to explain the peculiar inflammatory lesions by such a hypothesis alone.[1] Also, while racial tendencies may be a partial factor in their production, it should be borne in mind that although these lesions are very common in parts of Africa, they do occur in many other parts of the tropical world. There is nothing entirely pathognomonic about the tumors, but the changes we have described consisting especially of a dense fibrous tissue capsule enclosing inflammatory and necrotic areas in which peculiar, large, swollen lipoid cells with multiple inclusions in their protoplasm are situated, distinguish and separate at least one form of these nodules very strikingly from that one of onchocercal origin. Dr. S. B. Wolbach, who has kindly examined sections of these nodules, was especially impressed by the characteristics of the histological picture in general and the density of the fibrous tissue surrounding the areas of necrosis containing these lipoid or foam cells resembling xanthoma cells.

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[1] De Quervain has gone so far as to suggest there is in this condition a special strain of spirochaete for connective tissue, a fibrotropic strain weakly virulent and exerting its action in a locality subject to trauma.

amount of primary syphilis. Dr. Shattuck, in his clinical studies, observed but one case (No. 213), showing both primary and secondary lesions of syphilis, in Liberia.

Nogue [1] as chief of the venereal clinic at Dakar, has had an unusual opportunity for the observation of syphilis, and also points out that primary chancre and early ulceration of the throat are but seldom seen. The rarity of observations of primary lesions in syphilis in Africa also has been noted by Stannus and others. Neither primary sore nor secondary manifestation may give symptoms for which the native will seek treatment.

On the other hand, many cases of serpiginous ulcers, of periostitis, of swelling or destructive processes in the joints, of dactylitis, and of lesions resembling nasopharyngeal gummata in early or late stages, were observed by us in Liberia and the Congo, which might have been diagnosed from a clinical standpoint as lesions of tertiary syphilis. However, neither from a clinical or pathological standpoint did it seem to be possible to distinguish such lesions from those which have been described as tertiary in yaws. For this reason they were generally described clinically as forms of "treponemiasis." The ulcerative and joint and bone lesions observed by us in connection with treponemiasis are referred to on pages 276–277.

With reference to the clinical observations regarding syphilis, it may be remarked that cirrhosis of the liver and syphilis of the heart and aorta, and marked arteriosclerosis were not observed in the natives of Liberia or the Congo, nor were typical advanced cases of general paralysis of the insane seen in Liberia. It seems likely that even if cases of the latter condition occurred in certain parts of the interior of Liberia they would not be permitted by the other natives to live long.

Congenital syphilis was, however, observed in children in Liberia in Monrovia only, and one of these cases is illustrated in No. 28 (p. 49). This child showed also characteristic alteration in the shape of the cranium, general glandular enlargement, poor nutrition, anterior bowing of the tibiae and geographical tongue.

Maass [2] whose observations were made since our return from Liberia, states that while yaws is very common, syphilis is said to be absent in the northwestern portions of Liberia near the border of Sierra Leone.

It is also interesting to refer to the prevalence of cases of yaws and syphilis in the regions contiguous to Liberia and in the Belgian Congo. These observations have recently been collected by Stannus [3] in his excellent critical review of the subject. In Sierra Leone, in 1923, 144 cases of yaws, 48 cases of secondary syphilis, and 494 cases of the inherited disease were observed and treated. In the Ivory Coast, Botreau-Roussel points out that yaws is widespread in the hinterland, while Thiroux states that fifty per cent of the women in urban centers are infected with syphilis, many children showing signs of the congenital dis-

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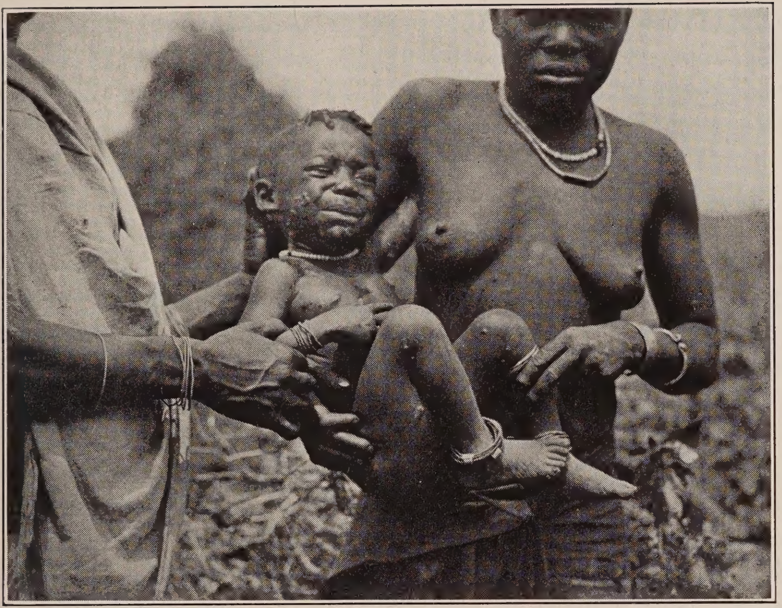
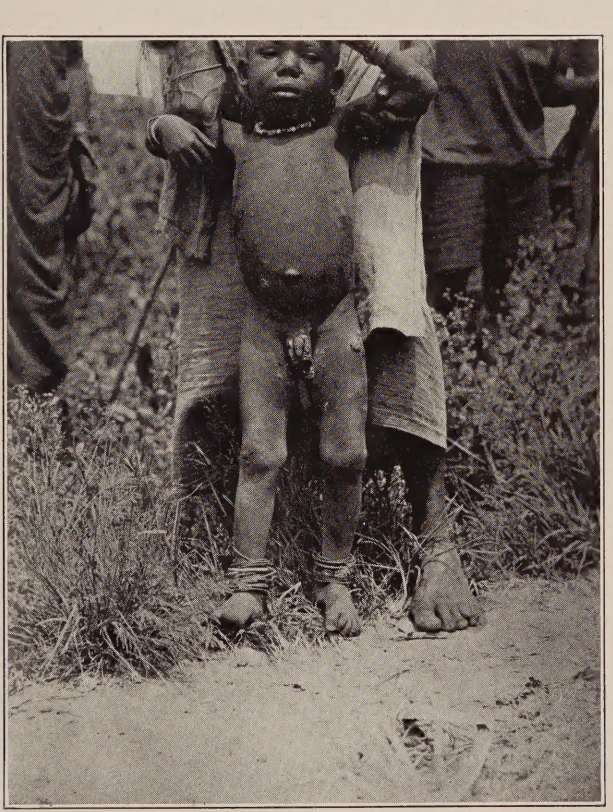
[1] Nogue: Ann. d'Hyg. Publique Industrielle et Sociale (1924), No. 3, p. 149.

[2] Maass: Arch. f. Schiffs. u Tropen-Hyg. (1928), XXXII, 221. Jour. Trop. Med. and Hyg. (1928), XXXI, 102.

[3] Stannus: Trop. Dis. Bull. (1926), XXIII, 1.



No. 206. — Case 592



No. 207. — Case 593

Mountain yaws near Kibati

ease. On the Gold Coast, in 1923 and 1924, there were observed for the whole colony 1,311 cases of syphilis and 5,312 of yaws, no cases of tertiary manifestations of syphilis being mentioned, while the secondary cases were about twice as numerous as the primary. In Nigeria, in 1923, 1,405 cases of yaws and 563 cases of primary syphilis and 1,128 of secondary syphilis were observed and treated. The statement, however, is made that yaws is relatively uncommon, while venereal disease is widespread.

Nogue [1] (1923–1924) reports that yaws is rare in Senegal and that he saw only four cases in four years at Dakar. Syphilis, on the other hand, was rampant. Of all the patients treated at the hospital, practically 100 per cent were syphilitic. Still births constituted 17 per cent, and 42 per cent of the children were said to die before the age of four years.

In the French Congo in 1921 and 1923, Chapeyrou states that a third of those treated in hospitals were affected with syphilis. Clapier in 1921 saw 2000 cases in a population of 45,000 in Lower Ubangi and 20 per cent of the children showed framboesial eruptions. Portois (1924) and van Nitsen (1920 and 1924) and Van den Branden (1922 and 1924) have reported upon the presence of yaws in the Belgian Congo, and Mattlet (1924) and Miguens (1924) in Urundi, where the disease is especially common. They report secondary eruptions in children and tertiary yaws lesions in adults, with no mention of syphilis. In Tanganyika in 1923, Davy reports 3,593 cases of yaws and 716 cases of primary, 1,638 cases of secondary and 253 cases of inherited syphilis treated in the Government hospitals. In Uganda in 1923, Keen gives the total cases of syphilis at 11,505 and of yaws, 3,376.

In some of the localities where the two conditions are noted it should be emphasized that the tertiary lesions have apparently been diagnosed generally as the result of syphilis, or in others as the result of yaws, the opinion sometimes varying with the observer.

Tertiary Yaws. N'gonde is the name used locally in parts of Central Africa, about Stanleyville for example, for tertiary yaws. Our observations of this condition were made particularly from the study of thirty-two cases.

In its fully developed and typical form, as we saw it, n'gonde is characterized by scarring and ulcerations which have a marked tendency toward bilateral symmetry. The lesions are most commonly seen where bone lies close beneath the skin; *e.g.*, on the forehead, face, joints of the shoulders, elbows, wrists, hands, lower legs, ankles and feet.

The scars in n'gonde are often puckered, like those produced by severe scalding. Pigment in them may be increased or diminished. Vitiliginous patches are common, particularly in those upon the lower legs. Recent scars often have a pink color. That the disease is very chronic is shown by frequent coexistence of old scars and active ulcers. The ulcers in the same case often show different stages of development. Healing by granulation tissue and overgrowth of skin may be going on beside an ulcer which is covered with slough and is extending.

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[1] Nogue: Ann. d'Hyg. Publique, Industrielle et Sociale (1924), No. 4, p. 149. Trop. Dis. Bull. (1926), XXIII, 4.

Both processes may even be found in different parts of a single extensive ulcer. The edges may be slightly swollen and undermined or the ulcer may lie in a plaque of smooth, light pink skin which is firm but elastic on palpation and which is so firmly adherent as to be quite immovable. The bases of such ulcers may be comparatively clean, and the exudate from them, instead of being purulent, is often the color of clear amber and noticeably viscid. Dr. Shattuck regarded such lesions as gummata of the skin.

Periostitis and bony thickening in cases of n'gonde, and likewise in syphilis, are common accompaniments of these ulcerative lesions. *Joint lesions.* Chronic or subacute arthritis, swellings probably gummatous, or ulcers in the neighborhood of the joints are, in addition, common manifestations of n'gonde. Such conditions are also seen without other important manifestations of treponemiasis.

Dactylitis. A few cases of dactylitis with fusiform swelling of one or more fingers, with or without active ulceration or destruction of bone, were seen. Case 385 (Illust. No. 219) showed loss of phalanges. Leprosy was excluded. Dr. Shattuck remarks that the largest number of cases of dactylitis of this type that he had seen were observed at Catbalogan in Samar in 1907 where for the first time he observed many cases corresponding to n'gonde. Some of them had gangosa or dactylitis with or without absorption of phalanges or spontaneous amputation. These cases had been collected as leprosy suspects for examination by Dr. V. G. Heiser, but no positive evidence of leprosy was found. Dr. Cullen, then Health Officer for Samar, said that the cases had resisted treatment with mercury and iodide. Many of these Catbalogan cases had severe contractures resulting apparently from destruction and scarring rather than from nerve lesions.[1] Cases of n'gonde showed the same type of contracture without sensory changes. The Catbalogan cases were then regarded by Shattuck as tertiary syphilis. He believes now that lesions of this type may be produced either by syphilis or yaws.

Elephantoid swellings were also occasionally seen in Liberia on the legs, in association with extensive scarring and ulceration.

A striking fact observed regarding n'gonde is that even when active lesions are extensive, the general health of the patient may be affected comparatively little, and that the mucous membranes may be of normal color and no evidences of a marked anaemia visible.

The cases of n'gonde varied very much in their clinical manifestations, as will be seen in a further discussion of some of the individual cases which will be used to illustrate special features of the condition. Case 553 (Nos. 208–210) is exceptional in that there appear to have been at one stage of the infection large abscesses in the muscles which may have originated from periostial disease in the deep-lying bones.

Gangosa or more or less destructive nasopharyngeal lesions were not uncommonly associated with n'gonde.

Both clavus and "crab yaws," the latter characterized by cracking of the soles of the feet, with moderate tenderness and swelling, were also observed particularly in negro porters in Liberia and in the Belgian Congo.

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[1] Shattuck: Philippine Jour. Sci. (1907), II, 551.

Before considering further some of the changes of n'gonde observed by us in Africa, reference may be made to the report of Hudson[1] upon a form of treponaematosis observed among the Bedouin Arabs under the name of *bejel.* Hudson states that the natives distinguish *bejel* from *faranghi,* the foreign disease, or syphilis, with a primary sore acquired in adult life by sexual contact. *Bejel* is not considered a venereal disease. There is no history of primary sore and everyone admits having had the disease in childhood, but no one expects to get it a second time. It is said that inoculation of the children is sometimes practiced. There are nasal catarrhal discharges, affections of the throat, and skin eruptions. Stannus, in reviewing this report, says that the description of the disease is that of syphilis and that yaws does not enter into the problem. The question, however, will remain in the minds of some, is *bejel* a form of syphilis contracted by children in the identical manner as yaws.

The occurrence of tertiary lesions in yaws. In earlier years some of the lesions that are today reported as tertiary manifestations of yaws were frequently referred to as syphilis. Some observers did not accept the ulcerative tertiary lesions as late manifestations of yaws. Powell,[2] writing in 1923 of his careful studies and observations made in Assam, says that no tertiary lesions were seen by him during the ten and one-half years his yaws cases were under observation. In three cases of syphilis, however, in two of which yaws was contracted, tertiary lesions occurred. A cracked and pitted form of plantar hyperkeratosis described by Castellani as a sequel of yaws he says is common in Assam and not rare elsewhere in India, but Powell disassociates it from yaws.

Sellards and Goodpasture[3] say that they are convinced that in many cases yaws terminates spontaneously with the secondary stage while in other cases it lies latent or proceeds to tertiary manifestations.

Ramsay[4] found chronic dermatitis and a worm-eaten appearance on the soles of the feet common among his 1000 cases, but tertiary lesions uncommon. However, arthritis occurred in three per cent, chiefly of the phalanges. Araujo,[5] also with a wide experience with the disease, says that gummatous ulcerations have never been observed in yaws patients and in six cases of goundou there was no evidence of yaws. Many other observers, however, find tertiary lesions in yaws very common, especially in Africa. Thus Callanan,[6] through whose hands some 12,000 cases of yaws passed in twenty-seven months, found that the tertiary lesions noted included gummata, periostitis and osteitis, which are common. Rarer lesions were pseudomycetoma, juxta-articular nodules and goundou, while gangosa was very common. The tertiary lesions were noted in seventy per cent of the adult males and females. Spittel[7] says that the quiescent period of yaws usually lasts from four to twelve years before tertiary symptoms appear. He adds that it is the general impression that the lesions of this stage are or may be due to syphilis.

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[1] Hudson: U. S. Naval Med. Bull. (1928), XXVI, 817.

[2] Powell: Proc. Royal Soc. Med. (Sec. on Trop. Dis.), (1923), XVI, 15.

[3] Sellards and Goodpasture: Philippine Jour. Sci. (1923), XXII, 219.

[4] Ramsay: Trop. Dis. Bull. (1925), XXII, 546.

[5] Araujo: Bull. Soc. Path. Exot. (1928), XXI, 387.

[6] Callanan: N. B. Thesis W. (1925).

[7] Spittel: Jour. Ceylon Branch Brit. Med. Asso. (1922), XIX, 1.

With reference to bone and joint lesions as tertiary manifestations of yaws, Maul,[1] in the Philippines, found such lesions in twenty per cent of yaws cases. Commonly x-ray examination showed rarefying osteitis affecting the inner parts of the bones and sometimes the outer surfaces, later with marked deformity of the bone outline. The condition was thought to differ from syphilis in that there was no periosteal proliferation and no thickening of the cortex of the bone. He points out that these conditions are very commonly described clinically under the term periostitis. Soetomo and Eichhorn [2] have also described bone atrophy as revealed by x-rays as being characteristic of yaws in contradistinction to syphilis. Clapier [3] has also noted osteitis of both the short bones and of the epiphyses of the long bones, while Egyedi [4] has described framboesial lesions in joints, tendons, sheaths and bursae among the natives of Nias, where he states yaws is common and syphilis uncommon.

Among others who have emphasized the frequency of the tertiary lesions of yaws is Van Nitsen [5] who examined 699 cases of yaws and found tertiary lesions in the majority, either appearing at the end of the secondary stage or from ten to twenty-five years later. Tertiary lesions chiefly take the form of serpiginous ulceration on the trunk and limbs. 500 cases presented ulcerated lesions, 178 cases of arthralgia, 74 arthritis, 72 ostealgia, 77 periostitis, 27 necrosis, and 2 bone rarefication. Hunt and Johnson [6] state that twenty per cent of their 2000 cases of yaws in Samoa, where syphilis is said to be absent, had periostitis.

Gutierrez [7] who studied 229 cases of yaws with tertiary lesions present in a third of their number, found periostitis, gummata, and keratosis to be common.

Differentiation of Yaws from Syphilis. While there is no difficulty clinically in distinguishing from syphilis the granulomatous eruption upon the skin which occurs as a manifestation of yaws, with reference to distinguishing the tertiary lesions of syphilis from those of yaws there is usually the greatest difficulty. Penris [8] emphasizes how commonly such tertiary yaws and tertiary syphilis lesions are confounded. Spittel [9] points out that tertiary yaws closely simulates tertiary syphilis and like it has two kinds of manifestations, gummata, and fibroid indurations. He believes gummata are as common in yaws as in syphilis. With reference to the differential diagnosis he says one may have to rely on the history of the case for the diagnosis. While he has not met with definite nervous symptoms in yaws, he thinks the nervous system is affected mildly and transitorily in some cases in this disease.

Stannus [10] also emphasized the difficulty in diagnosis between what are considered to be the tertiary manifestations of yaws and similar conditions which may be due to syphilis. He points out in his article published in 1926 that there has been no evidence of value in recent writings to show that the nervous system is ever affected in yaws.

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[1] Maul: Philippine Jour. Sci. (1918), XIII, 63.

[2] Soetomo and Eichhorn: Trop. Dis. Bull. (1926), XXIII, 18.

[3] Clapier: Trop. Dis. Bull. (1923), XX, 176.

[4] Egyedi: Trop. Dis. Bull. (1925), XXIII, 17.

[5] Van Nitsen: Ann. Soc. Belge de Méd. Trop. (1920), I, 39.

[6] Hunt and Johnson: Trop. Dis. Bull. (1923), XX, 840.

[7] Gutierrez: Trop. Dis. Bull. (1926), XXIII, 17.

[8] Penris: Trop. Dis. Bull. (1924), XXI, 794.

[9] Spittel: *Loc. cit.*

[10] Stannus: *Loc. cit.*, p. 10.

He, however, refers both in this and in a later report [1] to Harper's observations and belief that both general paralysis and tabes may result from yaws, in the Fiji Islands where syphilis has not been observed to occur.[2] Harper also found optic atrophy and aortic aneurism among the Fijians and refers to all these lesions as paraframboesial diseases. Parham,[3] working in Samoa, holds much the same view. He believes that the children in Samoa are invariably infected with yaws which renders them subsequently immune in adult life to syphilis, and that syphilis is practically unknown in Samoa. In this view he is upheld by Ritchie.[4] Lambert [5] after emphasizing that syphilis is almost unknown in the Fiji Islands, says that in the insane asylum there have been 182 admissions of natives during the past twenty years of whom 42 have died of general paralysis of the insane, and that none of these natives had syphilis. Cases of paraplegia responding to treatment with iodides and arsenical compounds were not infrequently met with. Parham not only thinks that tabes and general paralysis may result from yaws, but that yaws may be inherited. Hunt and Johnson [6] also believe that yaws infection may be hereditary. Choisser [7] states with reference to the condition of the nervous system in yaws, that the most common finding is spontaneous haemorrhage into the brain. In one case the haemorrhage occurred into the spinal cord. This was diagnosed clinically as tabes dorsalis, and aroused much interest inasmuch as up to date no case of tabes had been found. The autopsy finding, however, revealed to him the true nature of the condition to be a spontaneous haemorrhage into the central canal. In his present series of cases he found four spontaneous cerebral haemorrhages at autopsy. These all occurred in young adults with clinical histories and symptoms of yaws infection. They were not cases of hypertension, but on the contrary presented systolic pressures below what one might expect for their age.

Parsons,[8] in a more recent publication, states that it has been held that lesions of the central nervous system do not exist in Haiti because the Haitian disease is yaws and not syphilis. He points out that the disease as found in the cities of Haiti does not differ in any way, except for the absence of tabes and paresis, from the syphilis of the United States, and that the accumulation of autopsy and clinical records there now shows that the rural, non-venereal form of the disease known as yaws is capable of producing in Haitians all the lesions that syphilis can produce. He believes that the most rational explanation of the non-appearance of tabes and paresis in Haiti, where syphilis is universal, lies in the fact that malaria is also universal in that country. The idea that malaria may play a rôle in the prevention of the development of the later symptoms of yaws had also been advocated previously by Powell[1] and by Ramsay.[2]

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[1] Stannus: Brit. Jour. Ven. Dis. (1928), IV, 64.
[2] Harper: Kenya Med. Jour. (1925) II, 18.
[3] Parham: Amer. Jour. Trop. Med. (1922), II, 341.
[4] Ritchie: Med. Jour. Australia (1927), Supp. No. 13, p. 401.
[5] Lambert: Amer. Jour. Trop. Med. (1929), IX, 429.
[6] Hunt and Johnson: U. S. Naval Med. Bull. (1923), XVIII, 599.
[7] Choisser: U. S. Naval Med. Bull. (1929), XXVII, 566.
[8] Parsons: U. S. Naval Med. Bull. (1928), XXVI, 916.

Schlossberger[3] has shown that, in the inoculation of mice with a strain of syphilis virus and with one of *T. pertenue* from Nichols, an infection of the brain may occur in both instances. A piece of the syphilitic lesion from an infected rabbit was buried in a skin pouch in the mouse's back. It became absorbed in three weeks. The mice so treated showed no symptoms or signs of infection, but after ten months they were shown to possess a latent infection. Thus when they were killed and blood and portions of their organs, glands, spleen, and brain were injected into rabbits by the intra-testicular route, the gland and spleen gave positive evidence of the infection, and in the case of two syphilitic and two framboesial latent infections in the mice, their brain tissue inoculations into rabbits were followed by positive results. The inoculation of their blood into rabbits, on the other hand, gave negative results. In view of these experiments it seems possible that the brain in man may sometimes harbor the virus of yaws.

Williams[4] reports the case of a native who developed, a week after the last of three intra-muscular injections of bismuth sodium tartrate for florid secondary yaws, cerebral symptoms with coma, and died twelve days later. An autopsy was performed and revealed lateral sinus thrombosis. No other lesions were found in the body and no thrombosis of the veins in the buttocks or abdomen was discovered. The brain was sent to the director of the pathological laboratory and a report was given that there were changes in the brain similar to those found in general paralysis of the insane. Stannus, however, in reviewing this report does not consider that a relationship was established between the pathological lesions found and the yaws for which the patient was treated.

It has been remarked that typical tabes is extraordinarily rare among African natives. With reference to this point, we observed no typical cases of tabes or general paralysis in Africa, but we found numbers of cases of dementia in institutions in parts of Central Africa, confined with cases of sleeping sickness in which no trypanosomes had been found either in the blood or in the cerebrospinal fluid. As in these regions it is stated that the occurrence of yaws is almost universal in childhood, it may be that general paralysis will be subsequently regarded and reported as a manifestation of yaws in Africa, as it has in Fiji and Samoa. The cases that we saw of dementia and disturbances of the central nervous system in which no trypanosomes were found were being treated with anti-syphilitic remedies. Dr. Strada, at Coquilhatville, told us that the clinical picture of general paralysis is in his opinion accurately reproduced in some cases of trypanosomiasis. While Dr. Donadio at Stanleyville considers that syphilis of the central nervous system is relatively rare in that region among blacks, he makes such a diagnosis in disturbances of the central nervous system in which he is unable to find trypanosomes. In some of these cases the pupils may not react to light and while some of the cardinal signs of tabes are present, others are lacking. No fully developed cases of tabes have been seen by him.

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[1] Powell: *Loc cit.*

[2] Ramsay: *Loc. cit.*

[3] Schlossberger: Cent. f. Bakt. (1927), Orig., CIV, 1.

[4] Williams: Tanganyika Terr. Ann. Med. and San. Report for 1926, p. 105.

Chesterman[1] also says that he has not observed cases of nervous disease in association with yaws at Yakusu.

At Leopoldville, Dr. Van den Branden treats as syphilis such cases of disease of the central nervous system as show a positive Wassermann reaction and no trypanosomes. He does not consider the diagnosis entirely satisfactory, but it is the best method which is practicable there.

Several other French and Belgian physicians have suggested that there exists among the African natives a variety of syphilis which does not produce general paralysis and other late nervous symptoms, and Stannus has also noted that tabes is extraordinarily rare among African natives. However, even in the United States the negro is less likely to develop tabes or paresis than the white man.

With reference to the differentiation of the lesions of the bone in syphilis and yaws, the changes which have already been referred to as noted by Maul and others might well be regarded as merely clinical variations of the same disease. Polak[2] has emphasized the difficulty in making a diagnosis between the tertiary bone lesions of yaws and of syphilis except on the history of the case taken in conjunction with x-ray examination. He believes, however, that in framboesial lesions, rarefaction of the bone is seen and that in syphilis there is thickening and sclerosis. He, however, admits that in congenital syphilis a rather similar rarefaction may occur which is difficult to distinguish in tertiary yaws in a child infected as an infant. Osteitis deformans has been thought to be a late manifestation of syphilis.

Zimmerman[3] in the study of syphilis as seen in whites and negroes at the Johns Hopkins Dispensary in Baltimore, points out that bone syphilis is the most frequent lesion of tertiary syphilis in the negro and that neurosyphilis is more frequent in white patients than in negroes. The negro, as noted, is also less likely to develop tabes or paresis.

Such authorities as Manson-Bahr,[4] Spittel and Araujo, for example, state that the mucous membranes are not affected in yaws. However, Noel[5] has observed infection of the mucosa in the Cameroons and believes these lesions of yaws have been sometimes overlooked. Apart from the genital and anal regions, the secondary lesions of yaws were found in twenty-two cases on the mucosa of the mouth, in nineteen in the nose, and in four in the conjunctiva. The greatest number of cases were observed in childhood or early life. Castellani says that lesions of the mucous membrane are not very common and adds that granulomatous nodules may develop at the base of the tongue and on the nasal mucous membrane and more rarely in the larynx. Esler quotes the case of a child, aged two years, with florid secondary yaws, who developed laryngeal obstruction necessitating tracheotomy, and Callanan has seen a single case among many thousands showing a lesion on the tongue. Hunt and Johnson, among 2000 cases in Samoa, found less than five per mille with any lesions on the mucosa and in those cases the nasal mucous membrane was alone affected. Stannus, in citing such cases, says there is a strong suspicion that it is the mucocutaneous junction area which is involved, and not the mucosa. Acheson[1] has also found a number of cases of yaws in which the mucous membranes of the lips were involved. In eleven cases, three adults and eight children, the lesions were completely on the mucous membrane of the lip. In twenty-two cases the nostrils were blocked, but here the lesions sprang from the mucocutaneous junction.

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[1] Chesterman: Brit. Jour. Ven. Dis. (1928), IV, 64.

[2] Polak: Arch. f. Schiffs. u. Tropen-Hyg. (1927), XXXI, 530.

[3] Zimmerman: Trop. Dis. Bull. (1926), XXIII, 85.

[4] Manson-Bahr: *Loc. cit.*, p. 53.

[5] Noel: Ann. de Derm. et de Syph. (1921), II, 72.

Ayuyao[2] has reported upon tertiary manifestations of yaws in the nose and throat in the Philippine Islands. He also believes that the initial lesion occurs in the nose, rather than in the pharynx, though the pharynx and larynx may be primarily involved. Hallenberger[3] also illustrates and mentions a case with chronic granulomatous tissue about the mucous membranes of the mouth.

Miyao[4] has also reported and illustrated two cases with lesions of yaws on the external genitals. In the first case there were in addition to extensive granulomata on the skin, lesions on the lip, anus, and glans penis. The last are well illustrated. The disease was directly transmitted from this patient to his wife who developed initial yaws lesions upon the mucous membrane of the vulva.

It also has usually been stated that the viscera are never affected in yaws, but, as Stannus points out, *T. pertenue* has been recovered in earlier cases from glands, spleen, and bone marrow.

Some few visceral lesions have been ascribed to yaws in Fijians and have been called paraframboesial lesions. The optic atrophy and aortic aneurysm observed by Harper have already been referred to.

Choisser,[5] who has performed 526 autopsies at the Haitian General Hospital, has not been able to differentiate the visceral lesions of yaws and syphilis, and regards the lesions found at autopsy as those of yaws, from the clinical history. He says, however, that the histories in many cases had to be disregarded concerning the exact type of infection, inasmuch as conflicting statements were not uncommonly given by the patients during their stay in the hospital. Regardless of this, he says that he has observed a series of ten different cases of yaws pure and simple with a negative history of syphilitic infection and no evidence of scars on the genitalia. In eight of these cases there were aneurysms of the aorta, in one, a gumma of the brain, and in the other a spontaneous cerebral haemorrhage. He has described as a tertiary lesion of yaws, degeneration of the intima of the aorta with yellowish patches of atheromatous change, the lesions being as a rule about 2 mm. above the aortic cusps but not appearing to invade the valve itself. The atheromatous change may extend down to the iliac bifurcation. Aneurysms are stated to be extremely common in late yaws, all varieties being encountered. He reports that the heart muscle in old yaws cases seems to be definitely affected. The epicardium is more or less opalescent with porcelain-like patches. These areas are also frequently seen in the endocardium. In the liver Choisser frequently found small superficial punctate scars which showed on section areas of degeneration with associated round cell infiltration. Actual cirrhosis was rare. Gummata of the liver were also rare but did occur. Haemorrhages into the brain and cord were common, especially in young adults. Stitt and also Choisser illustrate the aortas from two cases of tertiary yaws showing marked aortitis, and two aortic aneurysms, thoracic, and abdominal, from cases of tertiary yaws.

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[1] Acheson: Northern Rhodesia Med. Report Health and Sanit. 1925 and 1926; Appendix, p. 125.

[2] Ayuyao: Jour. Philippine Med. Assoc. (1928), VII, 411.

[3] Hallenberger: Beihefte, Arch. f. Schiffs u. Tropen-Hyg. (1916), XX, 5.

[4] Miyao: Philippine Jour. Science (1930), XLI, 13.

[5] Choisser: Stitt's "Diagnostics and Treatment of Tropical Diseases" (1929), p. 156; Choisser: U. S. Naval Med. Bull. (1929), XXVII, 564.

Stannus alludes to the fact that a syphilitic may be infected with yaws and vice versa, and says that this is held sufficient by the majority to substantiate the two disease entities. The experiments of Powell[1] who reported six successful inoculations of syphilis in yaws in man and three of yaws in syphilis in man, support this view. But with reference to this point some of the evidence while not conclusive certainly tends to associate the two conditions very closely.

Jahnel and Lange,[2] using three strains of *Spirochaeta pertenuis* from different sources failed to infect by inoculation a number of patients with general paralysis of the insane, but in the following year[3] they succeeded with another strain of this organism in successfully inoculating a typical case of general paralysis, there having resulted a granuloma with scaly crust which contained spirochaetes. In a later publication,[4] they state regarding their further inoculative experiments of this nature, that they cannot be taken to support the idea of the unity of the treponemal virus but perhaps are only manifestations of a group reaction. They think, from their own observations and those carried out by other investigators, that the facts can best be explained by postulating a group of viruses of yaws and syphilis with characteristic yaws virus at one pole and characteristic syphilis at the other, tropical or indigenous native syphilis and some variety of framboesia being some of the intermediate forms. The human experiments by Sellards and Lacy[5] also demonstate the difficulties that might ensue in attempting to differentiate yaws and syphilis by inoculation experiments, particularly on account of the time when immunity following inoculation is established, and the time which it persists.

Differences observed in the immunity reactions in the laboratory between

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[1] Powell: Proc. Royal Soc. Med., Section Trop. Dis. and Parasit. (1923), XVI, 15.

[2] Jahnel and Lange: Klin. Woch. (1926), V, 2118.

[3] *Ibid.*, Muench. Med. Woch. (1927), LXXIV, 1487.

[4] *Ibid.*, Klin. Woch. (1928), VII, 2133.

[5] Sellards and Lacy: *Loc cit.*

S. pertenuis and *S. pallida* (which are identical morphologically) and in the inoculation of animals with the two viruses, may very well apply only to differences in individual strains of these organisms, since different strains give very different results. Much of the careful work of Nichols,[1] Brown and Pierce [2] and Kolle [3] and the observations of Chesney,[4] and others have emphasized this fact. Also the different pathological lesions obtained in rabbits by Pierce and Brown by the inoculation of yaws and syphilis virus might be explained by differences in virulence of the two strains or as protean manifestations of the same affection.

The earlier experiments performed by Neisser, Baermann, and Halberstadter,[5] and Castellani [6] seemed to show that in three instances monkeys previously inoculated with syphilis could subsequently be inoculated with yaws, and vice versa, that four monkeys inoculated with yaws could subsequently be infected with syphilis. But the work of Levaditi and Nattan-Larrier [7] showed that five monkeys which were first inoculated with syphilis were subsequently immune to yaws. The experiments, however, are not sufficient in number from which to draw definite conclusions. In connection with them, Schöbl [8] has shown that monkeys infected with yaws do not develop a high degree of immunity to the infection in less than seven months' time. Hence the positive results on reinoculation before this period would not be conclusive. Moreover, Schöbl after an extensive serological study of yaws and syphilis during several years, in his most recent publication with Miyao on the subject, concludes that Philippine monkeys that have gone through yaws infection produced by the Kadangan strain and were found to be highly immune to yaws, by repeated inoculations with homologous strains were also found to be immune to cutaneous inoculation with the Nichols strain of syphilis. He has therefore shown that a high degree of immunity to yaws protects against cutaneous infection with syphilis in Philippine monkeys.

With reference to experiments upon rabbits, the early experiments of Nichols [9] suggested that infection with yaws would not confer upon these animals protection against syphilis, but in these experiments the interval between inoculations was also comparatively short. More recently, however, Nichols [1] has brought forth evidence to show that rabbits that have been infected with yaws and have carried their infection for a comparatively long period of time, 91 to 376 days, may, in approximately fifty per cent of the cases, whether treated or not, be refractory to a subsequent inoculation with a strain of *Treponema pallidum* which is highly virulent for the rabbit.

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[1] Nichols: Amer. Jour. Trop. Med. (1925), V, 429.

[2] Brown and Pierce: Jour. Exper. Med. (1925), XLI, 673.

[3] Kolle: Deutsche Med. Woch. (1926), LII, 11.

[4] Chesney: Medicine (1926), V, 463.

[5] Neisser, Baermann, and Halberstadter: Munich. Med. Woch. (1906), LIII, 1337. Arb. a. d. kais. Gesundheitsamte (1907), p. 48.

[6] Castellani: Jour. Hyg. (1907), VII, 558.

[7] Levaditi and Nattan-Larrier: Ann. Inst. Pasteur (1908), XXVIII, 260.

[8] Schöbl and Miyao: Philippine Jour. Sci. (1929), XL, 91.

[9] Nichols: Jour. Exp. Med. (1911), XIV, 196.

Chesney [1] points out that there is a close parallelism between percentage of successful inoculations of syphilis obtained by Nichols in yaws rabbits, and the percentage of successful reinoculations obtained by others in syphilitic rabbits where heterologous strains of *T. pallidum* were used for the second inoculation. Volgtlin and Dyer [2] have also recently produced evidence to show that treated syphilitic rabbits which are refractory to a second inoculation with syphilis, are refractory to inoculation with yaws virus. Kolle [3] found that seven syphilitic rabbits were all refractory to infection with yaws virus, while of fifteen rabbits infected with yaws, nine, or sixty per cent could be successfully infected with syphilis. In his experiments at least 120 days elapsed between inoculations. These experiments again suggest that the syphilitic virus may at least in some instances be of greater virulence.[4] Some of the experiments of Reasoner [5] to the effect that rabbits which have had yaws lesions of the testicle are not immune to intravenous inoculation of syphilis, also suggest such a view.

Schöbl and Miyao [6] conclude that the *Treponema* of syphilis is far more resistant to adverse conditions prevailing outside the tissues of the host than the *Treponema* of yaws. They say the "*Treponema* of syphilis is panblastotropic. It can invade, multiply, and colonize all tissues. It does this with a mesoblastic preference and according to the law of sequence. It survives and produces lesions in the various tissues. The consequence is syphilitic manifestations on the skin, the mucous membranes, the internal organs and the nervous tissue. Treponemas of syphilis invade the cardio vascular system and consequently the placenta, resulting in congenital syphilis." They regard "the treponema of yaws an epiblastotropic. It invades, colonizes and produces lesions only in certain tissues, particularly the skin. Its invasion may extend to mucous membranes by extension per continuitatum from the skin. It lacks the mesodermic preference of the *Treponema* of syphilis. Consequently the internal organs, the nervous tissue and the cardiovascular system remain unaffected and the disease is not congenital."

The interpretation of some of these animal experiments may be complicated according to whether or not acquired immunity in syphilis is dependent upon foci of syphilitic infection somewhere in the body. Chesney,[7] after reviewing the evidence, apparently inclines to the view that during the course of syphilitic infection the host may develop an immunity and acquire a resistance against a second infection which may persist after the first infection has been eliminated by treatment. Kolle and Prigge,[8] on the other hand, from recent

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[1] Chesney: *Loc. cit.*, p. 525.

[2] Volgtlin and Dyer: Public Health Report, U. S. Pub. Health Ser. (1925), XL, 2511.

[3] Kolle: *Loc. cit.*, p. 11.

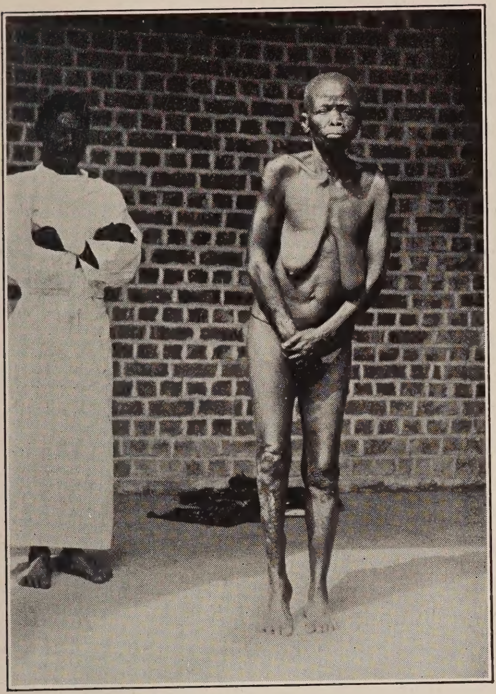
[4] Hifuka Kiyo (Japan Med. World [1929], IX, 299) has recently studied clinically and histologically the metastatic skin eruptions in rabbits produced by intravenous injection of the viruses of syphilis and of yaws. He finds that in these animals the differences observed are only in degree and are not absolute.

[5] Reasoner: Amer. Jour. Trop. Med. (1929), IX, 422.

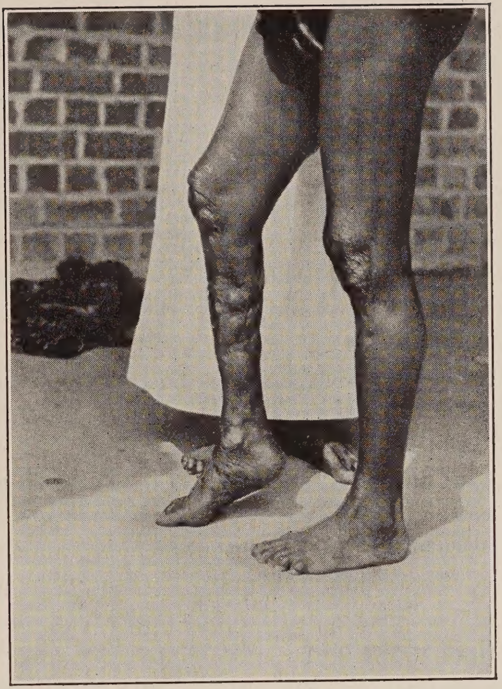
[6] Schöbl and Miyao: *Loc. cit.*, p. 103.

[7] Chesney: Medicine (1926), V, 503.

[8] Kolle and Prigge: Arbeit. aus dem Staatsinstitut f. Exper. Ther. u. d. Georg Speyer Hause zu Frankfurt A. M., Jena (1929), Heft 22, p. 18.



No. 208



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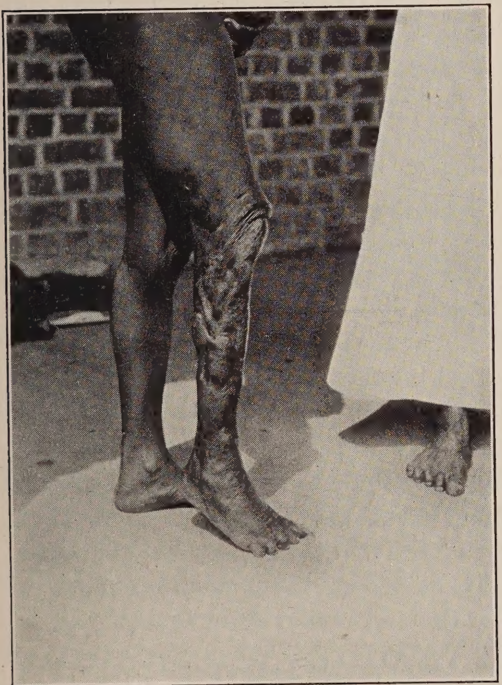

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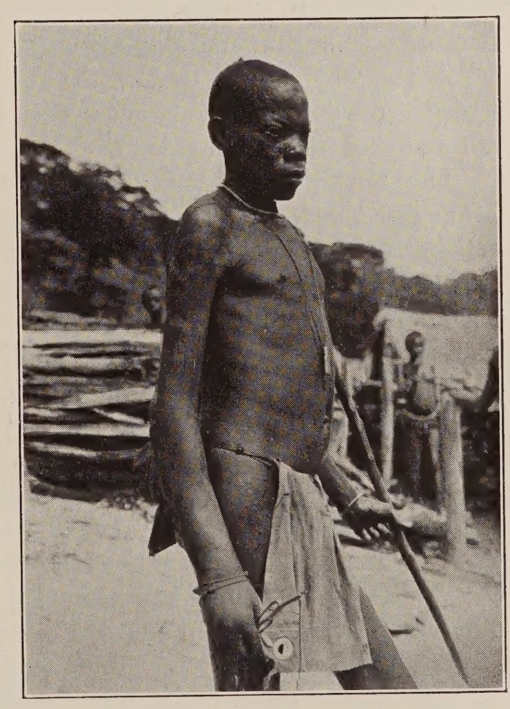

No. 211

N'gonde (treponemiasis), Nos. 208–210, Case 553. No. 211, Case 579 experimental work still believe that immunity in syphilis depends upon a latent infection.

Manteufel and Herzberg[1] after reviewing the recent work on the differentiation of the virus of yaws and syphilis by animal experimental inoculation, emphasize the want of uniformity in the results of different workers in many cases, and the necessity for gaining an insight into the reasons for these differences. From their own experiments, as well as those of previous observers, they conclude that so far there is no certainty as to either the unity or duality of the viruses of the two diseases.

Jahnel and Lange, while they say that all the evidence at the present time goes to prove that yaws remains yaws and syphilis, syphilis, also add that except for the typical secondary exanthem yaws cannot be distinguished from syphilis, and even in this connection they remark that a framboesial form of syphilide may occur. They further point out that it is only recently and in countries where syphilis is believed to be absent that many tertiary manifestations have been claimed as due to yaws.

Treponematosis. Butler, however, who has had unusual opportunities to observe these conditions in Haiti, is among those who have come to the conclusion that yaws and syphilis are one and the same disease, a condition which has also been especially emphasized by Bory, Muller, and Peterson, and Manteufel and Herzberg.[2] Butler and, subsequently, Peterson[3] have suggested the term "treponematosis" as including both infections. They take the view that there is morphological identity of *Treponema pertenue* and *T. pallidum* and that the two organisms show parallel serum reactions, that the clinical course is identical in the two conditions and that also the specifics are the same in the two. However, many other observers with very wide experience in the subject will not accept entirely these views.

The recent discussion upon the subject by such eminent authorities as Manson-Bahr, Stannus, Chesterman and others, published in the British Medical Journal of Venereal Diseases[4] emphasizes the great diversity of opinion still held with reference to the identity of the two diseases in Great Britain.

One must frankly admit that from a clinical standpoint the term "treponematosis" or treponemiasis is especially convenient for the tertiary lesions of yaws and syphilis which cannot often be distinguished, except sometimes by the history of the case — and the history is very frequently a very doubtful point among many of the peoples who commonly suffer with yaws.

The term "yaws" is also most satisfactory clinically in its application to the characteristic secondary granulomatous cutaneous lesions. Colonel Harrison,[5] recently speaking of the relationship of the two affections, has expressed the opinion that nothing has been said which disproves the hypothesis that the differences between yaws and syphilis lie in the soil rather than in the seed.

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[1] Manteufel and Herzberg: Abhandl. a. d. Gebiet d. Auslandskunde Hamburg (1927).

[2] *Ibid.*, Arch. Schiffs-u. Tropen-Hyg. (1929), XXXIII, 661.

[3] Butler and Peterson: Jour. Lab. & Clin. Med. (1927), XII, 670. Butler: U. S. Naval Med. Bull. (1928), XXVI, 553; Ann. Intern. Med. (1929), III, 175.

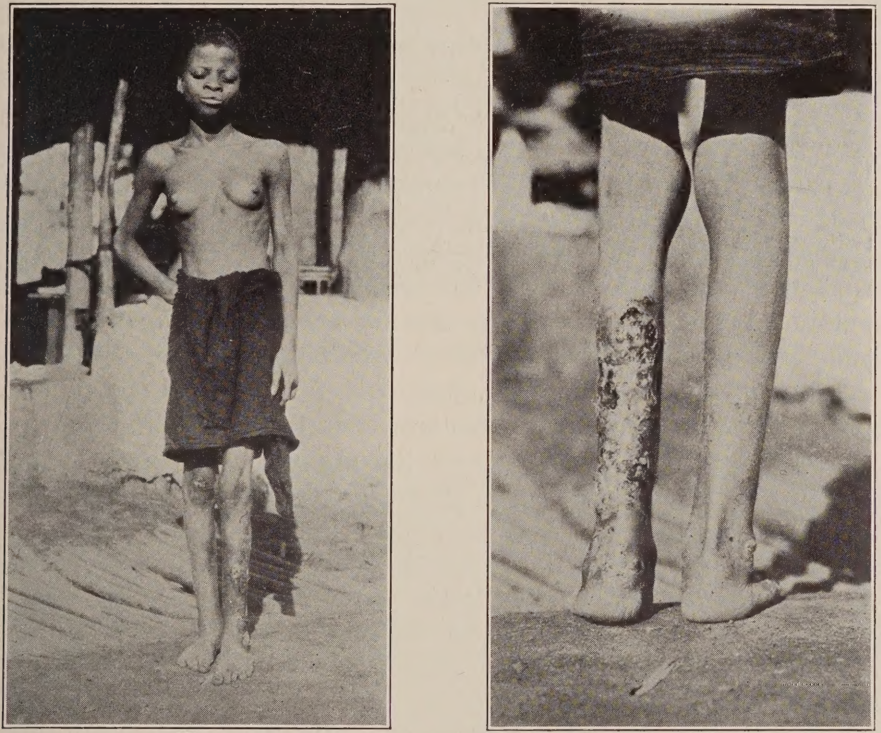
[4] Brit. Med. Jour. Ven. Dis. (1928), IV, 44.

[5] Harrison: Brit. Jour. Ven. Dis. (1928), IV, 70.

Pathological histology of yaws. It recently has been suggested that the comparison of the histopathological conditions observed in yaws and syphilis may give more definite information regarding their differentiation.

During the present expedition we were able to obtain pathological material for the histological study of these late lesions of treponemiasis.

The tissues removed from the patients in which the clinical diagnosis was treponemiasis (to which we have also referred under the local name of n'gonde) were excised both from areas where the epidermis was preserved, as well as from the edges of the ulcerative lesions. The margins of the ulcers were frequently thickened and hard and infiltrated. In some instances the bases of them were dirty and showed necrotic shreds, but more commonly they were flattened and clean and covered with granulations. The edges were often sharp and sloping, but sometimes were undermined. The ulcerating lesions were frequently more or less irregular in outline and had often become confluent. In other instances they were separated by retained skin or by retracting scar tissue. Many of the scars about the ulcerative lesions were thick and furrowed. Some of the shallow depressed scars were pink in color, while others retained no visible pigment and still others were often even more deeply pigmented. Nodular lesions, both subcutaneous and of infiltrated skin, were also removed. Many of the lesions resembled gummata of the skin, and among them different



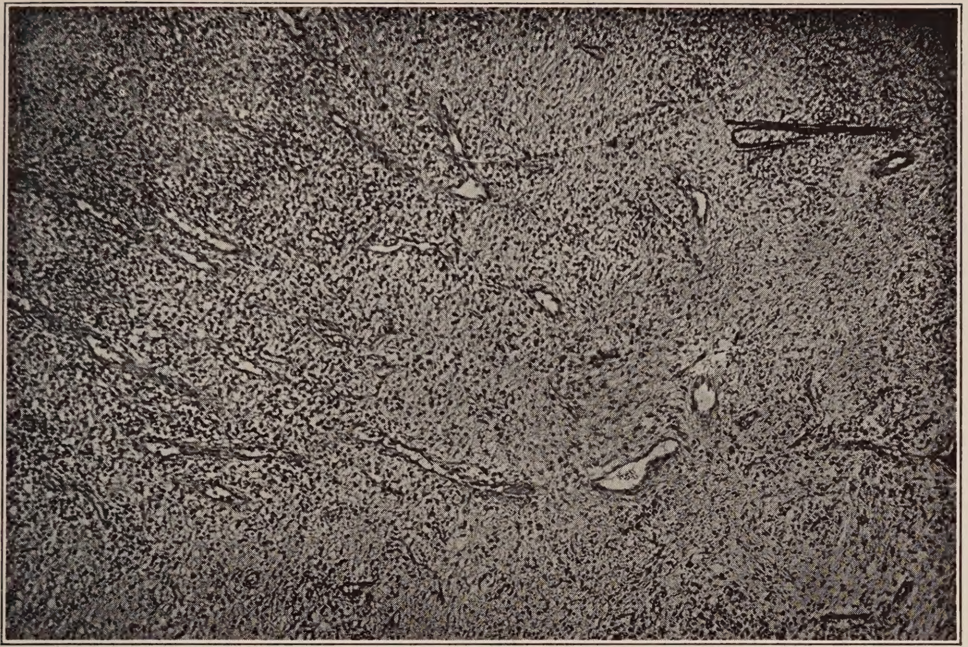
Nos. 212, 213. — N'gonde (treponemiasis), Case 222 stages of the condition, — the nodular, caseous, ulcerative, healing, and cicatrizing, — were represented.

The tissues from these lesions were placed in Zenker's solution or formalin immediately after their removal and were later sectioned and stained in haematoxylin and eosin, Giemsa's solution, by the Ziehl-Neelsen-Gabbett method for acid-fast bacilli, by Levaditi's silver impregnation method, and in a few instances by Weigert's stain.

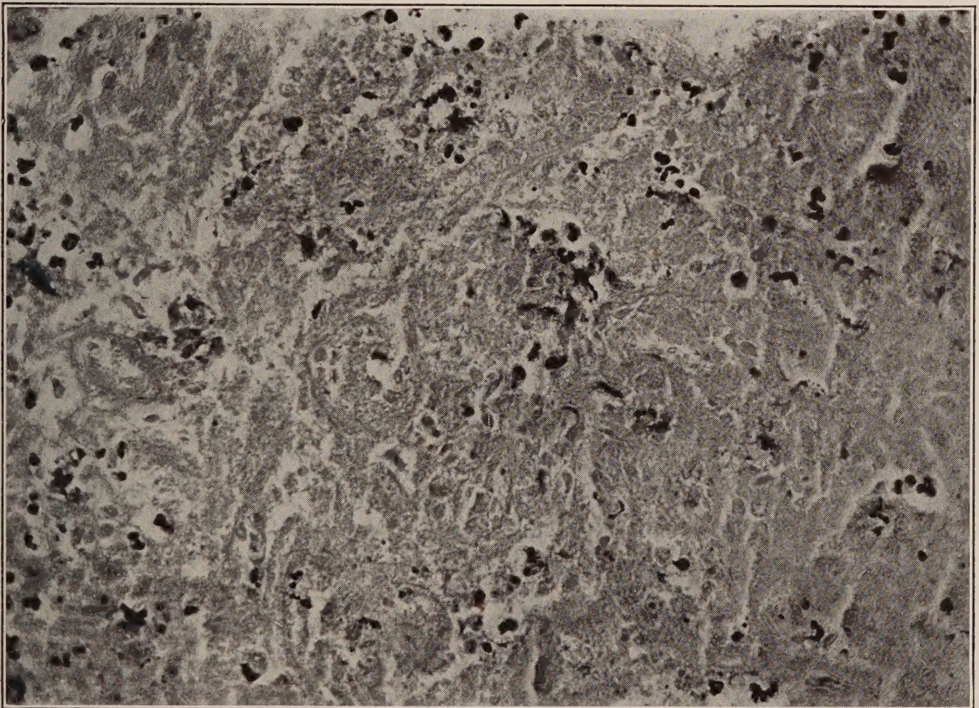
The histological appearance in some of the cases varies considerably. However, in general, in the vicinity of the ulcerative lesions the condition is characterized by the presence of granulation tissue in which there are some areas richly cellular and others where proliferation of the fibrous tissue is marked, but usually with few, if any, giant cells. The inflammatory process is usually of rather a diffuse character and not sharply limited in nodular form. The cellular exudate is composed particularly of plasma cells, endothelial cells, fibroblasts, polymorphonuclear leucocytes and small round cells. In a few instances, nodular areas were observed in the corium and subcutaneous tissues, in the center of which coagulation necrosis has sometimes occurred. Around the central areas the tissue is characterized by the presence of proliferating fibroblasts and numerous round cells. This zone in turn is surrounded by an area of granulation tissue which is richly vascular and contains many round cells, endothelial cells, plasma cells, and a few polymorphonuclear leucocytes. Eosinophils are not prevalent or noticeably increased in number in the tissues. The vessel walls show in some areas moderate endarteritis and thickening of the walls and evidence of periarteritis with the proliferating endothelial cells extending into the surrounding tissue. However, marked evidences of extensive endarteritis and thickening of the vessel walls is not present. Rather surprising is the slight tendency in the ulcerative lesions to the secondary invasion of the tissues by spirochaetes and fusiform bacilli and by cocci, as is seen, for example, in phagedenic ulcer. Spirochaetes were not found in the corium in any of the many sections studied. Acid-fast bacilli were also especially sought but were not found.

In Case 222, a Liberian albino negress (Nos. 212–213), large numbers of *Blastomyces* were found in the necrotic ulcerative lesion on the left leg, but only near the surface of the lesion. These *Blastomyces* were not present in the deeper portions of the tissue. In this patient, in addition to the numerous ulcerative lesions and extensive scarring of the skin, there was distinct thickening of the periosteum of the anterior surface of the tibiae. The photomicrograph (Illust. No. 214) illustrates the cellular infiltration, as well as the character of the granulation tissue showing numbers of newly-formed blood vessels in the corium and with no apparent pathological change in the walls of the larger vessels.

In No. 215 (Case 405), is illustrated the characteristic central area of coagulation necrosis sometimes observed in the subcutaneous tissues and already referred to. In this case, the tissue was removed from near the edge of the ulcer with a portion of the apparently normal overlying skin. The ulcer was



No. 214. — Photomicrograph of section of the ulcerative lesion of Case 222, showing character of cellular infiltration and condition of blood vessels in the corium

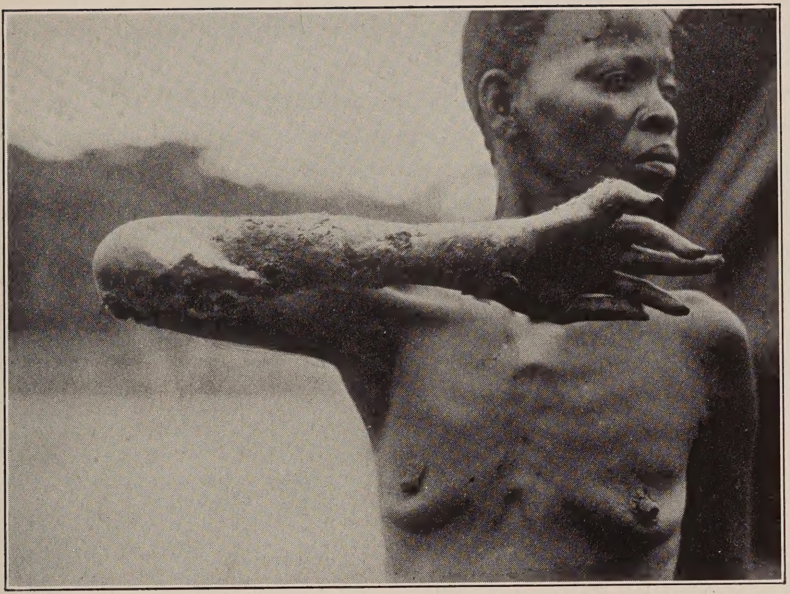


No. 215. — Photomicrograph showing central area of coagulation necrosis in n'gonde, Case 405

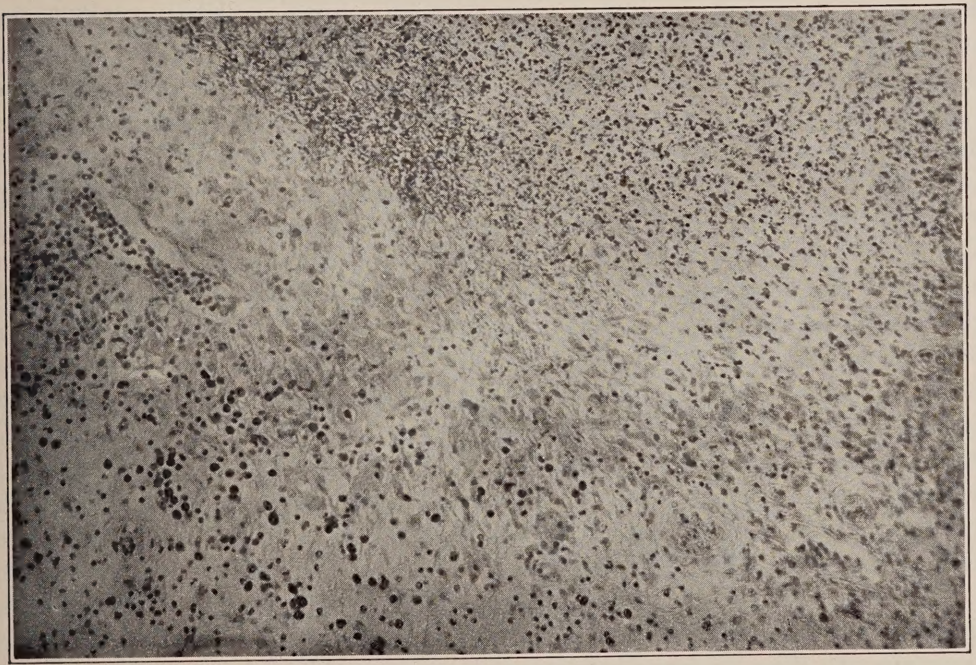
situated over the malleolus of the right ankle. The ankle, especially in its outer aspect, and the dorsum of the foot were swollen. The ulcer itself was very irregular in outline, indurated and with elevated margins. A portion of its base was composed of granulation tissue and another part covered with yellowish slough. In the vicinity of the ulcer were whitish, elevated scars.

Cases 187, 203, 217, 385, 402–404, 553, and 579, will serve to illustrate very well other features of the condition. Case 187 (No. 216) illustrates both confluent and circumscribed, suppurating, as well as healing, lesions. The patient was a member of the Jarquellis tribe in Liberia, a woman about thirty years of age, who stated that the duration of the condition was three years, and that it began on the back of the wrist. There were no other cases in the family. Scarring was extensive on the distal two-thirds of the right forearm, part of the scar being depigmented and part hyperpigmented. On the under side of the elbow and forearm there were situated a number of ulcers varying from 2 to about 4 cm. in diameter. Their bases were usually covered with yellowish slough. There was a similar ulcer, about 5 cm. in diameter on the dorsum of the wrist, and other ulcers on the proximal phalanx of the little finger and the knuckle of the right finger. These ulcerations were surrounded by depigmented scars. The little and ring fingers were stiff and useless, the middle finger more flexible. The subcutaneous tissues of the fingers were slightly swollen and indurated. There was no tenderness except near the margins of the ulcers. Over the lower part of the tibia on the right side was a superficially encrusted lesion. There was no general glandular enlargement. The skin sensation on the arms was apparently normal. The ulnar nerve on the left side was not thickened, while that on the right was beneath an ulcer. In some of the sections of the tissues from this case the papillae are lengthened, and extend well into the mucous layer almost to the granular layer. There is marked infiltration with plasma cells and a few leucocytes at the base of the papillae, but the infiltration does not extend to any great extent into the papillae toward the surface. Other portions of the sections show a more extensive infiltration of the corium with endothelial cells, leucocytes, plasma cells, and fibroblasts. There is much endothelial proliferation about the walls of the vessels. In No. 217 is illustrated the more or less zonal character of the infiltration with a central area of necrosis.

Case 553 (Nos. 208–210) represents a stage in which the disease has apparently run its course. This patient, an old negress observed near Stanleyville, was well nourished and apparently in good general health. There was very extensive scarring over the cheeks, bridge of the nose, backs of the hands, thighs and legs. Over the third and fourth metacarpals of the left hand the scars were adherent to the bones, indicating the previous existence of a destructive process beneath the skin. There were similar scars on the right patella and on the dorsum of the foot. The fresh scars on the right calf and marked shrinkage of the muscles indicated a deep destructive process. A resulting contracture on this side had drawn the heel up so that the patient was obliged to walk on the ball of the foot and the movements of the ankle were limited. The toes also were involved in



No. 216. — N'gonde (treponemiasis), Case 187



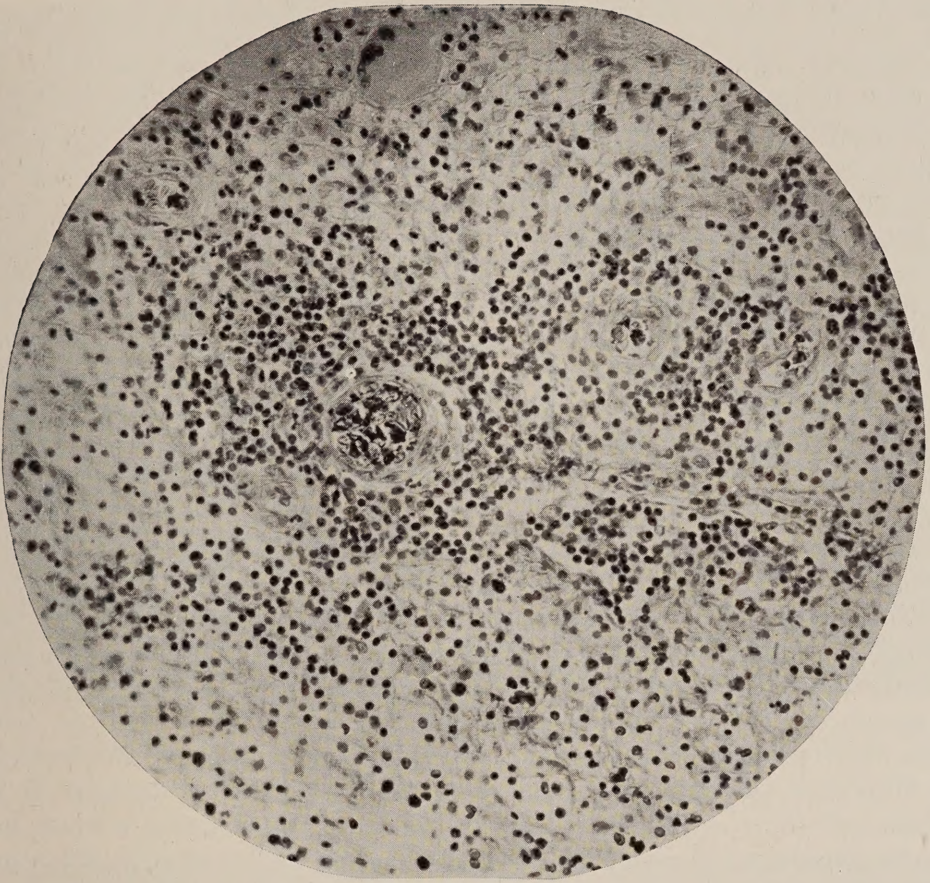
No. 217. — Photomicrograph of section of the lesion (Case 187) illustrating central area of necrosis in upper left portion of photograph and infiltration of diffuse character about it in the corium

the contracture. Other scars on the backs of both thighs indicated deep destructive lesions which had caused much loss of substance in the muscles. A large scar over the right shin exhibited complete depigmentation in some places and partial in others. The cartilage of the nose was nearly all gone and there was a perforation of the septum. The nasal bones and palate were intact. It was noted that the apparent good health of the patient, in spite of the extensive residual lesions, is a frequent manifestation of these cases of treponemiasis or tertiary yaws. Apparently in this patient the disease has run its course.

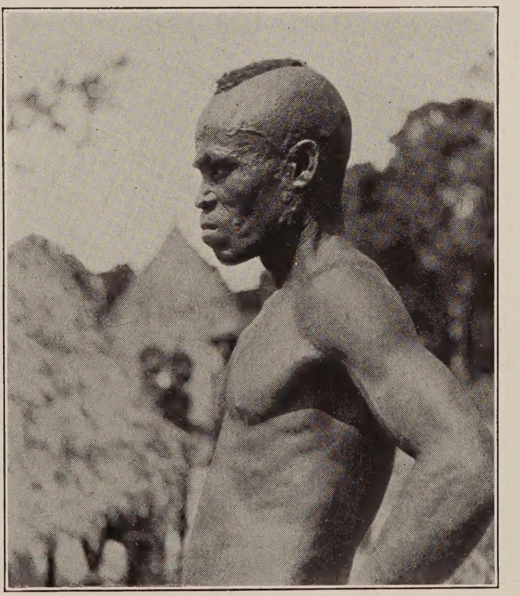
In Case 385 (No. 219) there also were no ulcerative or suppurating lesions of the skin, the tissues being taken from nodular or infiltrated cutaneous lesions. It, therefore, is of interest to refer particularly to the clinical notes regarding this case.

This patient was a Liberian of the Gibi tribe, about forty years of age, well nourished and apparently in good health. There were many pitted scars on the face, somewhat suggesting old smallpox, but the larger scars on the face were apparently due to some other process. On the right upper arm there were two infiltrated lesions serpiginous in outline, with the margins elevated for some 3 or 4 millimeters, and with slight depressions in the center. The lesions themselves measured about 2 to 6 cm. in diameter and their color was pinkish-brown. On the anterior surface of the thighs there were symmetrical lesions of similar character to those just described on the arm. There were also many small depigmented spots of skin scattered over the arms, face and chest. Some were at the sites of old scars, others seemed to be independent of the scars. In addition there were nodular formations in the skin. Several of these, measuring about 1 cm. in diameter, were present on the posterior surface of the right upper arm; the skin over them was scaly. On the right side of the face, from the ear to the angle of the jaw, there was a series of nodules 0.5 to 1 cm. in diameter, and there was slight thickening and scaling of the epidermis along the edge of the left ear. There was also nasopharyngeal disease, with destruction of the cartilage and septum of the nose. The nasal palate was nearly all destroyed and there were ulcers in the posterior portions of the pharynx. There were also evidences of other destructive lesions consisting of an old scar on the terminal phalanx of the right thumb and loss of the tip of the middle finger. These were attributed by the patient to an injury in childhood. However, the little toe on the right foot presented a constricting band, as in ainhum. The lesion on the left foot apparently was of a similar nature in an earlier stage. Portions of tissue were taken from the patient from the different nodular and macular lesions and hardened both in Zenker's solution and formalin and stained as already referred to on page 290.

The histological study of the three portions of tissue excised reveals some changes not observed in those tissues from cases with ulcerative lesions which have already been discussed. In places the epidermis is not greatly altered. The stratum corneum is not more distinctly thickened than is frequently observed in a native African skin and there is only a moderate degree of proliferative acanthosis. In other areas the stratum mucosum is distinctly thickened without there being still any hyperkeratosis. In the more abnormal areas of the skin,



No. 218. — Photomicrograph of small vessel with endothelial proliferation and cellular infiltration in the surrounding corium (Case 187)



No. 219. — N'gonde, Case 385

downgrowths of the epithelium into the corium have occurred (No. 222). The papillae, however, are generally not well marked and do not extend to a great depth into the epidermis, and while a few are increased in length none are seen to reach at the surface to near the corneal layer. In some areas the papillae have disappeared. The prickle cells in some places show considerable and apparently a normal amount of pigment, but in other areas the pigment is almost entirely absent from them. The epidermis is not infiltrated with leucocytes and the pathological changes are much more marked in the corium than in the epidermis. In the corium there are observed in all the pieces of tissue a few epithelial pearls resembling those seen in epidermoid carcinoma. In the corium also there is especially a large amount of newly-formed connective tissue showing in many areas very extensive cellular infiltration. The papillae share to some extent in this infiltration, but it occurs more especially below them and in the deeper layers of the corium.

The cellular infiltration consists of proliferated endothelial cells, fibroblasts, plasma cells, and small round cells. In many instances it is diffuse, while in others it exists in broad more or less longitudinal bands, or in clumps in the corium. In still other places it is distinctly nodular in character and tubercle-like in structure (Nos. 220, 221).

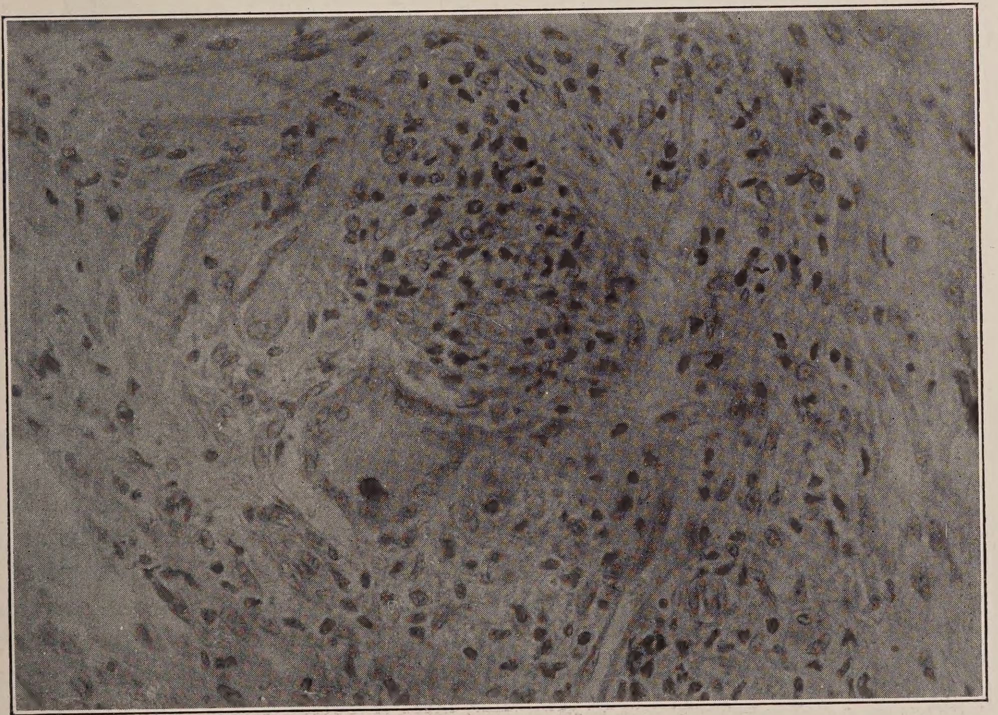
Giant cells are also numerous and are particularly present in the nodular areas where there are also numerous epithelioid cells and much proliferation of the fibroblasts and numerous round cells. In some instances the large areas of cellular infiltration are surrounded by rather dense fibrous tissue in which nuclei are not abundant. Many of the blood vessels show endarteritis, proliferation of the endothelial cells and thickening of the walls, though there is not marked evidence of periarteritis and extension of the endothelial cells into the surrounding tissue. The condition might suggest syphilis, but the numerous giant cells in the corium (and not in the region of striped muscle) are not in accord with such an idea.

The condition also suggests tuberculosis, but the case, from a clinical standpoint, did not suggest tuberculosis and no tubercle bacilli could be found in any of the many sections studied. Although leprosy had been suggested by some of the clinical features, leprosy is not particularly suggested by the pathological histology. The "lepra cells" are not present, and in lesions of this nature if the condition were leprosy, one might expect that lepra bacilli would probably be plentiful.

Giant cells are not a feature of primary or secondary yaws, though they are, of course, sometimes found in the tissues from yaws cases.

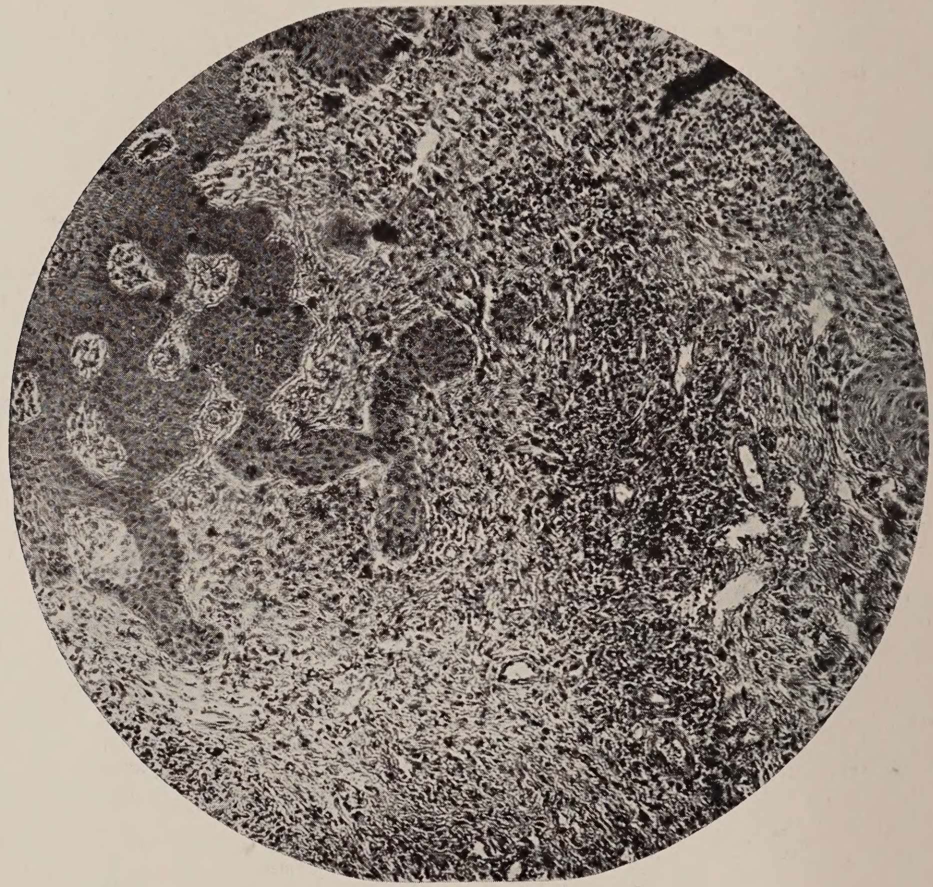
The lesions in this case give evidence of a chronic inflammatory process with formation of much granulation tissue in which, however, the more acute process of the disease has been arrested. Polymorphonuclear leucocytes play a very small part in the infiltration. The more acute degenerations of the newly-formed tissue commonly observed in yaws and syphilis are no longer occurring in this case. However, the numerous scars on the skin give evidence that apparently previously an ulcerative stage of the disease existed.

No. 220. — Showing downgrowth of epithelium and character of infiltration in the corium. Zeiss objective AA, compensating ocular 6. Case 385



No. 221. — Illustrating nodular character of the lesion with giant cell formation. Zeiss objective DD, compensating ocular 6. Case 385

The histological picture, also, is not that usually observed in primary or secondary lesions of yaws, or in the primary lesions of syphilis. No spirochaetes were found in the tissues stained by Levaditi's method. However, it is well recognized that spirochaetes are not usually found in the late lesions of either syphilis or framboesia, and Goodpasture [1] was even unable to find spirochaetes in the histological study of the *secondary* lesions of yaws a short time after they had received treatment by the injection of neosalvarsan.



No. 222. — Photomicrograph of downgrowth of epithelium, cellular infiltration, and condition of blood vessels (Case 385)

We have already, in previous publications, described and compared the earlier lesions of yaws and syphilis. In syphilis, the primary lesion begins as a papule which, almost from the beginning, exhibits erosion of the surface epithelium, the underlying tissue becoming thickened and indurated, particularly on account of the great accumulation of cells in the skin and subcutaneous tissue. The *Spirochaeta pallida* infects primarily the epidermis. It is found chiefly between the epithelial cells in the epidermis, later affecting the lymph spaces and blood vessels of the corium. The organism lies particularly in the connective tissue in the lymph spaces between the cells and various fibrils, in the adventitia and more rarely in the intima of the blood vessels. The inflammatory reaction which results consists particularly of plasma cells, endothelial and polymorphonuclear leucocytes, occasionally eosinophils and fibroblasts. Mitosis of the endothelial leucocytes, fibroblasts, and lymphocytes is common. The epidermis often shows infiltration with leucocytes and plasma cells. In the corium the infiltration is especially perivascular, in the papillae, and also interstitial.

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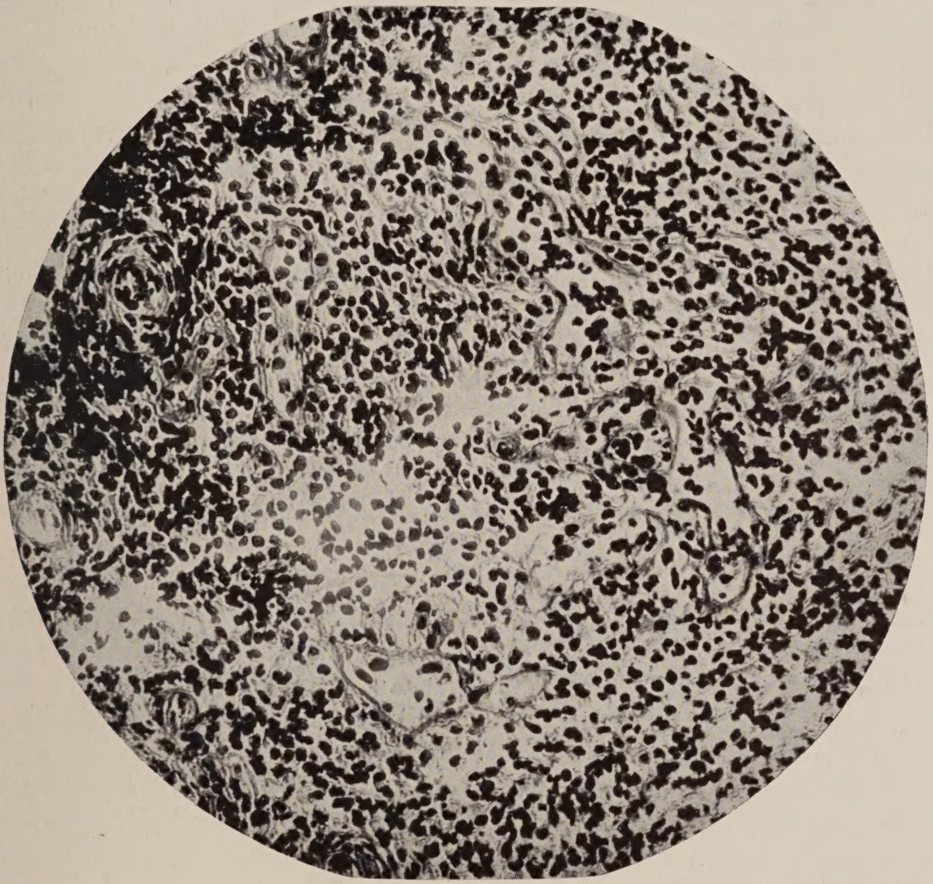
[1] Goodpasture: Philippine Jour. of Sci. (1923), XXII. 263.



No. 223. — Case 403. Photomicrograph of small vessels with endothelial proliferation and infiltration of the corium

A striking feature often observed is the accumulation of large numbers of endothelial cells about the blood vessels and lymphocytes, the walls of the blood vessels being sometimes filled with cells. Such a picture is especially observed about the arteries when the smooth muscle cells have undergone necrosis and the internal layer has become greatly thickened.

Regeneration in the corium takes place both around and between the blood vessels with infiltrations of endothelial leucocytes, lymphocytes, polymorphonuclear leucocytes and particularly proliferating fibroblasts. Such a process also often leads to a thickening of the intima and narrowing of the lumen and sometimes to obliteration of the vessels.

Giant cells are frequently found in the older lesions but are usually not prevalent except when the advanced lesions occur in regions where striped muscle fibers are present. In such lesions, Landois [1] states, giant cells are always present.

In the more advanced lesions of syphilis where suppuration and gummatous conditions have supervened, the cellular infiltration observed has a greater tendency to diffuse spread than to the formation of nodules such as are seen in tuberculosis and to a less extent, in framboesia. The gummatous lesions in syphilis are especially characterized in addition by a peculiar form of granulation tissue, richly cellular. The infiltration, however, may sometimes be zonal in character. In the center there may be an area of caseous coagulation necrosis in which fibrous tissue and the contours of the blood vessels can still be distinguished. External to this is frequently an area or zone in which fibroblasts, epitheloid cells, round cells and a few giant cells are observed, the whole being enclosed in more dense fibrous connective tissue. Finally, at the periphery, there may be a zone of newly-formed granulation tissue rich in small round cells, plasma cells and a few leucocytes and newly-formed blood vessels. There is a marked tendency to fibrous change in such lesions and, where the gummatous formation is extensive, they often lie in cicatrizing connective tissue in which the walls of the vessels are infiltrated by cells and thickened, and there may be infiltration by round cells and plasma cells in the vicinity.

The examination of caseous gummata for spirochaetes practically always results negatively. In contrast to tuberculosis with tubercle formation, the syphilitic lesions (as pointed out especially by Baumgarten) retain numerous blood vessels and this fact, he believes, as well as the great tendency to fibrous changes, is a very important point in differentiating the syphilitic from the tubercular lesions.

In the examination of the primary and secondary granulomatous lesions of yaws histologically, the papillae are often elongated and may be frequently seen in the base of the ulcer of the yaw, sometimes almost reaching the surface. There is usually much hyperplasia and thickening of the epithelium and below this a dense infiltration, especially with plasma cells.

The *Spirochaeta pertenuis* is found usually only in the epidermis, though recently Goodpasture [2] has demonstrated that it may occur, though rarely, in the perivascular connective tissue in certain of the long papillae which extend far up into the thickened epidermis. Schöbl [3] has found the spirochaetes during the acute stage in the lymphatic glands near the framboetic lesion in experimental animals, but says that in contradistinction to syphilis they are never present there after the lesion itself has healed.

A striking feature of the lesions in yaws is the great thickening of the epidermis and the degenerations which occur in the epithelial cells. In many instances there

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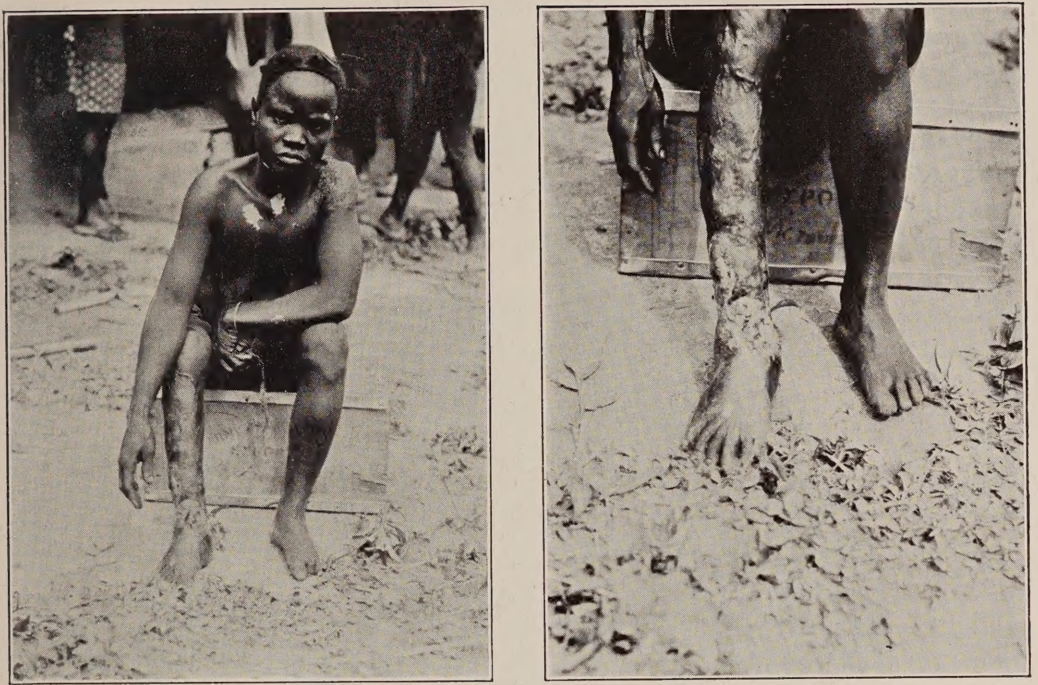
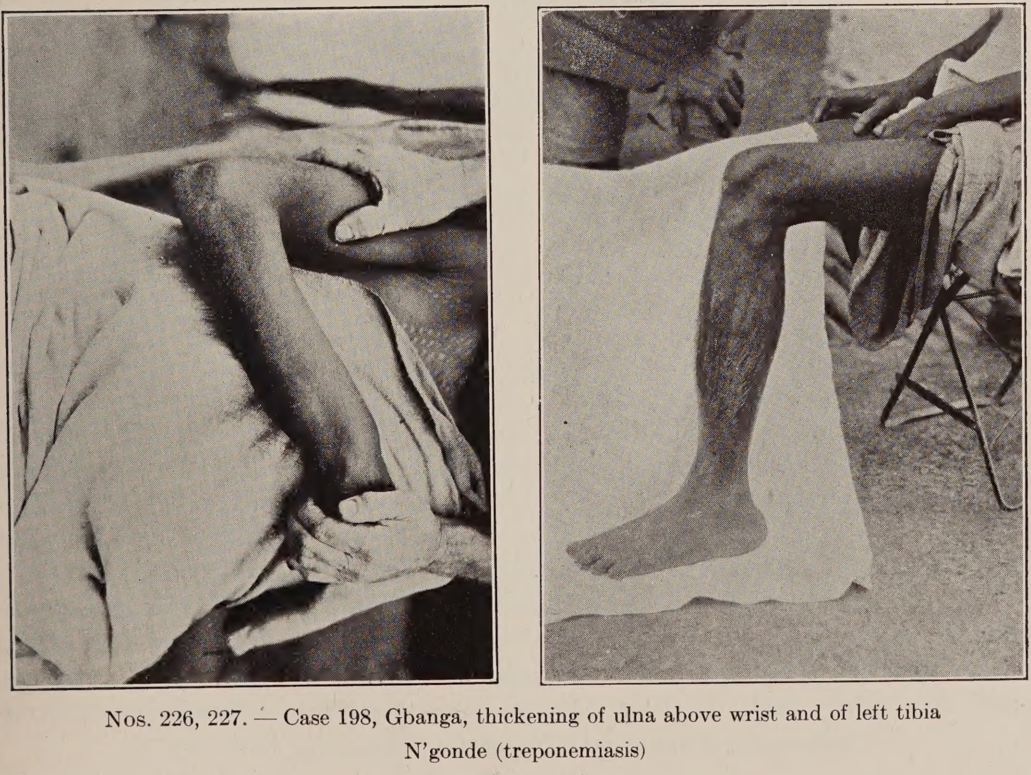
[1] Landois: Beiträge zur Klin. Chirurgie (1909), p. 63.

[2] Goodpasture: Phil. Jour. of Sci. (1923), XXII, 268.

[3] Schöbl: *Loc. cit.*

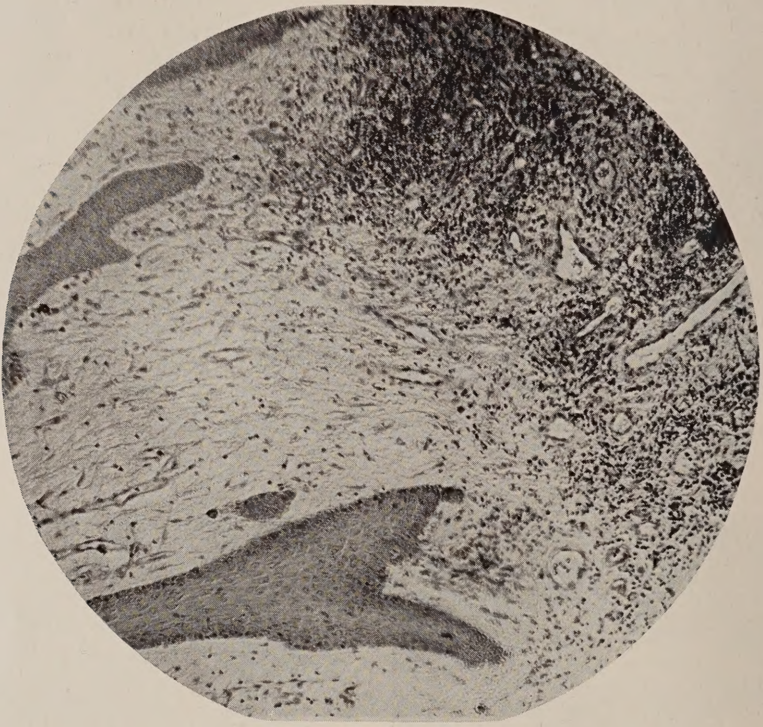


Nos. 224, 225. — Case 402, Chekomma



Nos. 226, 227. — Case 198, Gbanga, thickening of ulna above wrist and of left tibia
N'gonde (treponemiasis)

is hyperkeratosis, much of the thickening of the epidermis being due to serous exudate and leucocytic infiltration. In the epidermis, the leucocytes may be grouped in circular masses as in miliary abscesses, or scattered profusely throughout the epidermis. The elongated papillae are often vascular, infiltrated with lymphocytes and leucocytes and show small haemorrhages. The corium usually shows extensive infiltration, particularly in the deeper portions, and in the well-developed lesions, plasma cells are very numerous and constitute the great majority of the infiltrating cells. In addition there may be small lymphocytes and an increase in fibroblasts. In many of the cases there is no marked perivascular cellular infiltration, which is usually more common in syphilitic lesions.



No. 228. — Case 402. Photomicrograph illustrating downgrowth of epithelium, infiltration of deeper layers of corium, and condition of blood vessels

We have not (prior to the investigation of the African material obtained on this Expedition) studied pathological material obtained from cases with a diagnosis of tertiary yaws. So far as we have been able to ascertain, Hallenberger[1] in the Cameroons alone has compared the tertiary lesions of yaws with those of syphilis. He has also referred to the primary lesions.

In comparing the histological picture of the late lesions of yaws and syphilis, he points out that in both conditions chronic inflammatory formations occur in which there is a tendency to degeneration of the newly-formed tissue, and that while each of these diseases possesses these common characteris-

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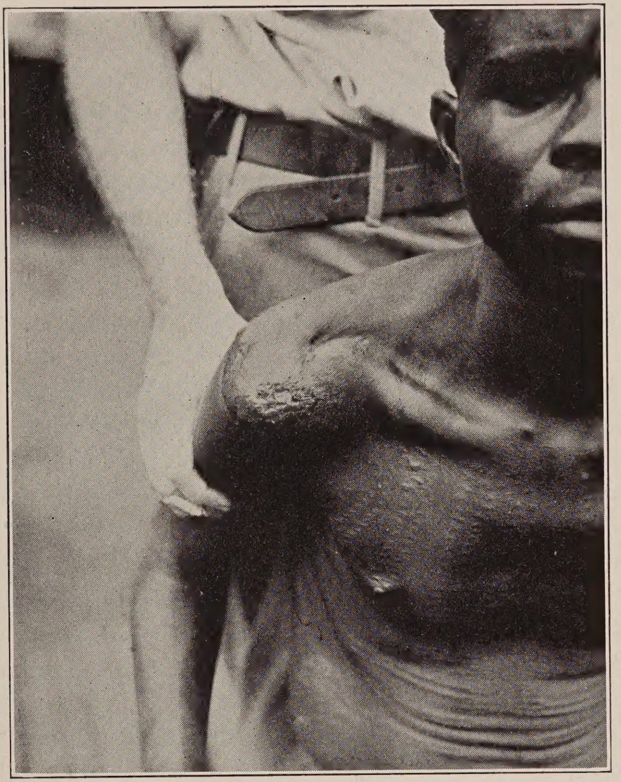
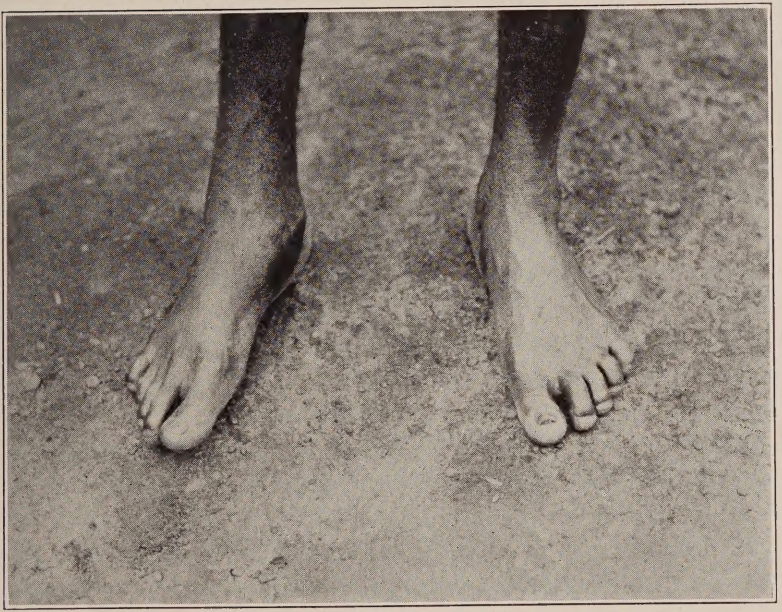
[1] Hallenberger: Beihefte 3, Arch. f. Schiffs-u. Tropen-Hyg. (1916), XX, 5.





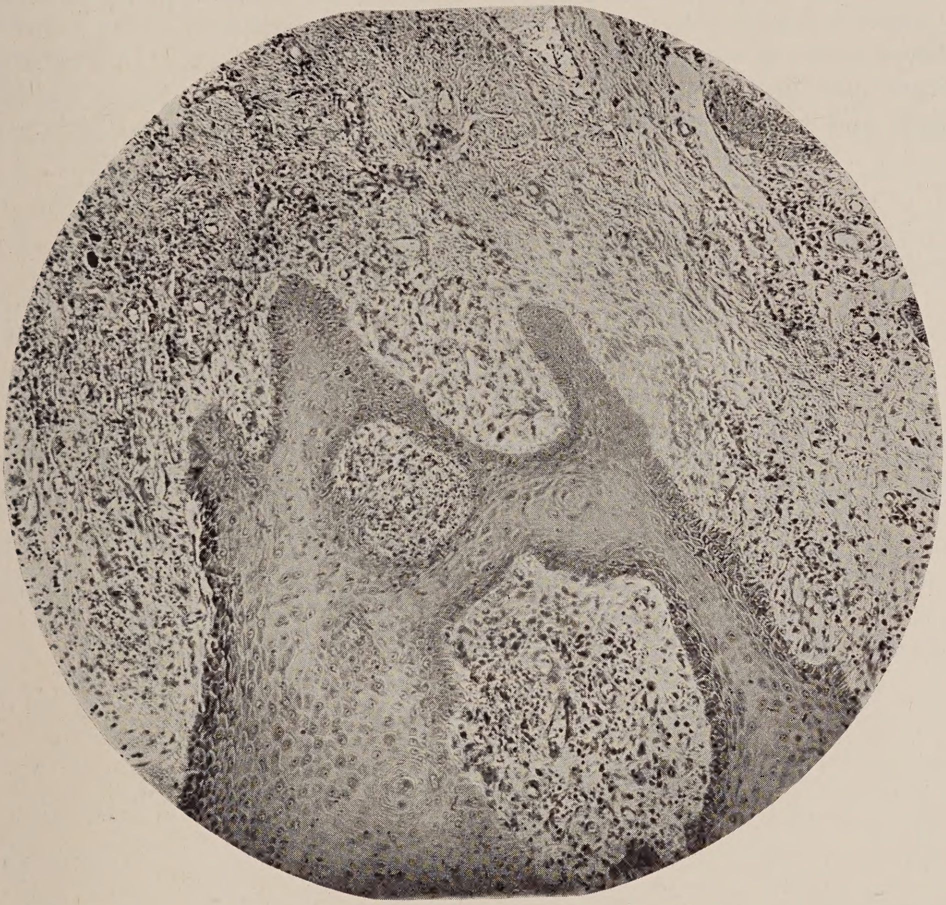
Nos. 229, 230. — Case 203, irregular scars on right shoulder with crusted lesion in center, scar over sternum, induration of tibia and swelling and tenderness of right ankle

N'gonde (treponemiasis)

tics, certain special characteristics sometimes serve to distinguish them, even though they have only a very relative diagnostic value. He emphasizes that this is true because these distinctive characteristics are not present in a uniform and regular way in all stages of the pathological processes. In the structure of the granulation tissue of the nodular tumors, the lymphocytes and plasma cells are the paramount feature. However, in the beginning he remarks one will often be able to distinguish the nodular syphilitic lesion owing to the fact that it is sharply delimited and very compact through an infiltration of round cells, these cells separating the area from the surrounding, less compact, newly-formed connective tissue. In the case of framboesia the cellular infiltration has a very much less indistinct margin or zone of connective tissue, and the zone of connective tissue also shows an infiltration with leucocytes, and there is an inflammatory zone. Hallenberger believes that the same distinction applies to gummatous formations, the growth of newly-formed connective tissue in both syphilis and yaws being surrounded by a compact wall of lymphocytes. However, only in the case of syphilis is the sharp boundary preserved for a long time. In case of gumma in framboesia, a diffuse area of infiltration is very soon formed.

He also believes that an additional point in diagnosis is given by the degeneration of either the chronic inflammatory granulation tissue or, in other cases, of the newly-formed connective tissue, which degeneration begins in the center of the infiltration. In the case of syphilis this degeneration takes place from caseation or through mucous or fatty degeneration; in the case of gumma in framboesia, it occurs through gelatinous degeneration or by means of a purulent softening (eitrige Einschmelzung). The latter is more common and is also observed in framboesial nodules in which, though more rarely, necrosis may occur. Hallenberger believes that this purulent degeneration is not attributable to syphilis and that if such degeneration occurs it is an indication that the condition is not syphilitic.

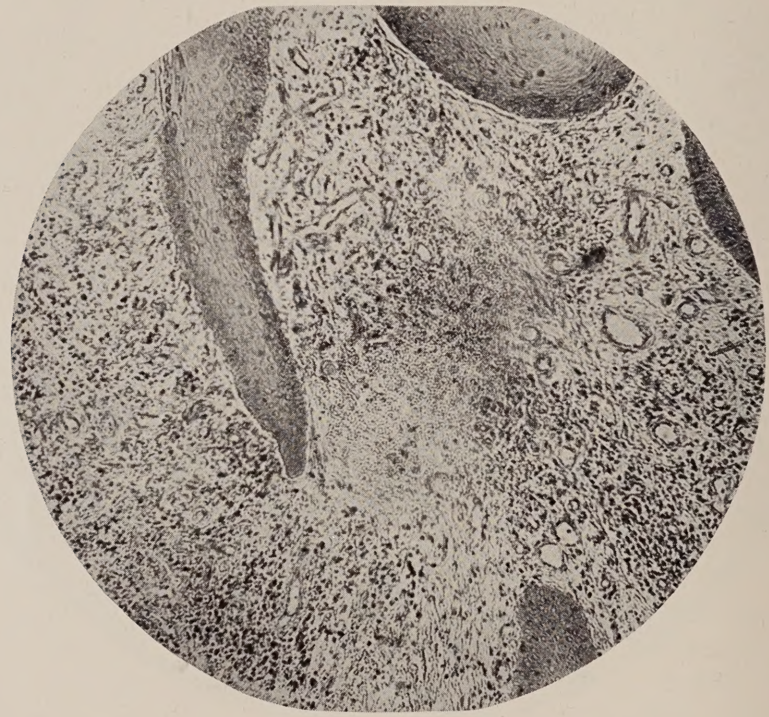
He points out that these characteristics of the two diseases, which are more or less specific, disappear as soon as the formation of the ulcerative lesions is complete, when secondary infections may occur which likewise alter the picture. In such instances, the syphilitic infiltration is modified as a result of the extensive invasion with leucocytes and the otherwise sharp border of the syphilitic infiltration observed in the earlier stages of the infection, becomes indistinct. This is especially true in the corium which the earlier lesions of syphilis have not usually appreciably modified. He states that for these reasons in many of the late lesions, the two disease processes can no longer be distinguished from one another by the histological examination or, indeed, from other chronic ulcerations of the skin. In the ulcerative lesions, he points out that the marked proliferation of the epithelium along the margins of the ulcers is no special feature of framboesia. He believes, however, that a characteristic that is almost always present in the late lesions of framboesia is the behavior of the plasma cells, though he states that this also cannot be given absolute value for diagnosis. He remarks that just as the quantitative amount of plasma cells is different in tuberculosis and syphilis, so it is not impossible that there is a difference in syphilis and framboesia with regard to the manner of arrangement of the plasma cells. He believes that in framboesia one may find rings or zones of cells which consist only of plasma cells, and that these are found directly around the vessels of the papillary bodies, such vessels being delicately broadened or entirely unchanged. This infiltration is also observed about the network of vessels of the subpapillary layer. These layers of plasma cells lie, however, more commonly below the papillae, particularly at the point of branching of the vessel that leads to the papillae. These cells are often so numerous that the papilla appears to be completely lined with them. In his study of framboesia he has found such a condition common and, as he has never observed it in syphilis, he thinks it is worthy of some attention, although he does not wish to give it a pathognomonic rôle. He believes that the only character that is reliable and that can be used for diagnosis which is peculiar to syphilis, and occurs in all stages in similar typical form, is the classic modification of the



No. 231. — Case 217. Photomicrograph illustrating infiltration of corium and papillae, and downgrowth of epithelium with abscesses in the stratum mucosum

blood vessels. He believes that the presence or absence of this typical modification of the vessels is the point that allows one to decide which of the two diseases is present, and it is true in the cases of syphilitic condylomata and papillary lesions of framboesia as well as in the later lesions of these two diseases.

In some respects the descriptions given by Hallenberger correspond with our own observations, already outlined in this chapter. We, however, have not observed such clear-cut and characteristic appearances as he sometimes outlines, either in our study of the early or late lesions of yaws. Unfortunately, all syphilitic tissues do not show the classical, typical modification of the blood vessels, and we believe that there is often considerably greater variation in the pathological changes in different cases, so that in many instances, particularly in the tertiary stages, the syphilitic lesions cannot be distinguished from the framboesial ones by the histopathological appearances. Hallenberger himself has recognized these difficulties, and, in fact, points out that gummatous lesions of the two affections may be indistinguishable from one another.[1]



No. 232. — Case 404. Photomicrograph showing downgrowth of epithelium, condition of blood vessels, and infiltration in corium about them

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[1] While this Report was in press, Howard Fox (Jour. Trop. Med. and Hygiene (1930) XXXIII, 26) has reported upon the histological examination of two cases of secondary and two of tertiary yaws, the microscopical examinations of which were made by Highman. He states that in one section giant cells were found, in another the vascular changes roughly suggested syphilis, and in all the intima and media were swollen. No productive inflammation, however, was found in the vessels as in syphilis. (The histological changes in rabbits are referred to on page 286, Footnote 4, of this Report.)

From a consideration of the clinical, serological, and histological changes regarding the two conditions which have been outlined in this chapter, it seems obvious that they are closely related. Perhaps in yaws we have a modified virus of syphilis, a less virulent one producing a disease that has been modified by the portal of entry in many years of successive passage of the virus through the epidermis in black-skinned races, and by the habits of life of these people and the climate and hygienic conditions under which they live.

XXI

GANGOSA, RHINOPHARYNGITIS MUTILANS, AND GOUNDOU

Gangosa was found to be not uncommon in both Liberia and in the central Belgian Congo (Nos. 233–239). More or less extensive destructive nasopharyngeal lesions were not uncommonly found to be associated with the conditions known as n'gonde. Any or all of the structures of the nose might be attacked or even completely destroyed. The same process was also observed involving the pharynx and the upper lip.

In gangosa we also have a lesion about which it is often impossible to say whether it is a late manifestation of yaws or of syphilis. The majority of those who have recently written upon the condition have expressed the opinion that it is a tertiary manifestation of yaws. Such an opinion has probably in some instances been given particularly on account of the fact that yaws in childhood, prevails in those districts where gangosa is also found, and where, generally, genital syphilis is not observed to be common.

Among the recent observers who record gangosa as a manifestation of yaws are Van Driel, Gutierrez, Van Dijke, Bakkar and Hoessen, Dubois, Waar, Callanan,[1] Bittner,[2] Maass[3] and Acheson.[4] On the other hand, Beurnier and Clapier, Maxwell[5] and Araujo[6] do not regard it as a manifestation of yaws, but rather of syphilis. Blonden[7] has reported upon a case of destruction of the nose, upper lip, and part of the cheeks by syphilis, which was said to have been cured by a course of treatment with 914, given by rectum. Mayer[8] believes that while the condition has been associated with leprosy, tuberculosis, and syphilis, such relationship has certainly not been established. He also states that it has not been conclusively demonstrated that yaws is the cause of true gangosa, although he adds that tertiary framboesia can cause the same destruction. He also refers to the fact that leishmaniasis can sometimes produce the same appearance and refers to a case in New Guinea in which Breinl found a *Blastomyces* (*Cryptococcus mutilans*) which he believed to be the cause. Ziemann[9] whose wide experience in tropical infections gives special weight to his view, also does not consider that

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[1] Cited by Stannus: Trop. Dis. Bull. (1926), XXIII, 84.

[2] Bittner: Amer. Jour. Trop. Med. (1926), VI, 123.

[3] Maass: Jour. Trop. Med. and Hyg. (1928), XXXI, 102.

[4] Acheson: Northern Rhodesia Med. Report on Health and San. Conditions (1925–1926), p. 125.

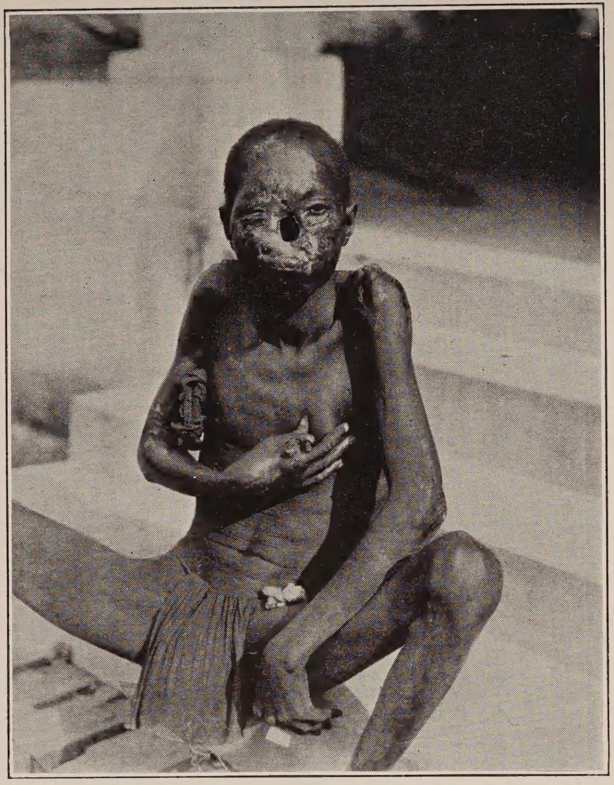
[5] Maxwell: Trop. Dis. Bull. (1926), XXIII, 84.

[6] Araujo: Bull. Soc. Path. Exot. (1928), XXI, 387.

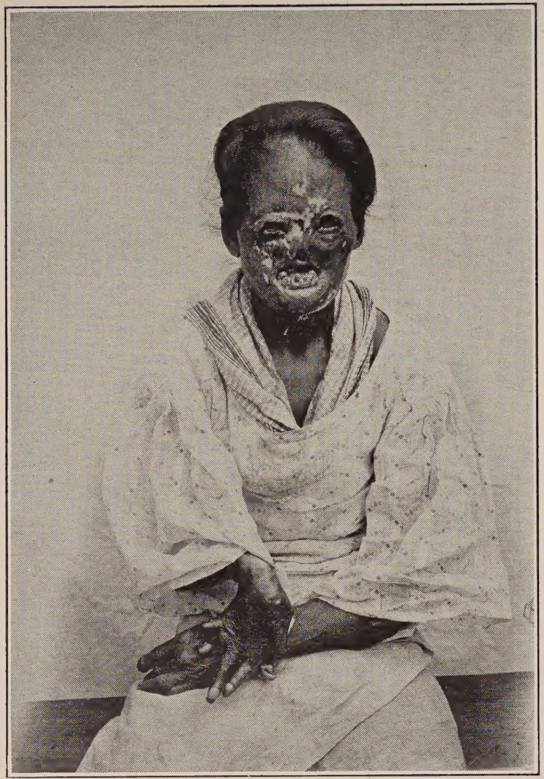
[7] Blonden: Bull. Soc. Path. Exot. (1927), XX, 6969.

[8] Mayer: "Exotische Krankheiten," Berlin (1929), p. 325.

[9] Ziemann: Beihefte, Arch. f. Schiffs-u. Tropen-Hyg. (1926), XXX, 161; and Abhandlungen aus dem Gebiet der Auslandskunde, Hamburg (1927), XXVI, 618.



No. 233. — Gangosa, Case 531



No. 234. — Leprosy and gangosa

yaws has been demonstrated to be the cause of gangosa, and believes that its etiology in many cases is doubtful.

Gangosa is obviously a condition which occurs only in localities where proper treatment is not available or among ignorant and unhygienic people who neglect treatment. Some of the older clinicians will remember that cases resembling gangosa, particularly the earlier manifestations of it, were occasionally observed in the clinics of a number of the cities both in Europe and in the United States before the days when the modern, efficient treatment of syphilis had been established.

Secondary infection with different micro-organisms invariably plays a rôle in modifying more or less the appearance of the lesions of gangosa as it does in other ulcerative lesions of the mucous membranes of the nose, mouth, and throat (noma, for example).

In more recent years, a number of observers have sometimes attributed this condition to *Leishmania* in different parts of the tropics; probably through incorrect interpretation of the microscopical appearance observed or inability to recognize and unfamiliarity with the appearance of *Leishmania* and the lesions produced by it.

Apparently Hallenberger [1] is the only observer who has recently examined the condition from the pathological histological standpoint. He believes that rhinopharyngitis mutilans belongs to the syphilis framboesia group of lesions, and in the absence of the classical inflammatory changes of the vessels which are present in syphilis he regards it as a late lesion of framboesia.

Photograph No. 233 (Case 531) illustrates a patient, a negro woman between thirty and forty years of age, whose arms were thin but who was not particularly poorly nourished. The mucous membranes were of good color. Part of the upper lip, the nose, including the septum and turbinates, and the hard and soft palates were destroyed by the disease. On the posterior surface of the pharynx was a pocket-like lesion containing a yellowish slough. There was very extensive scarring on the cheeks, lips, and around the eyes, causing ectropion, and on the shoulders, right elbow, and back of the hand. The eyebrows, which were included in the areas of scar, were thin, and the lids reddened, and there was conjunctivitis. Contraction of the scar had caused the ectropion of the left side, while the eyelashes had disappeared. The right eye was destroyed. There were many scars over the shoulders and arms, and over the shoulders and at the bend of the elbow there were superficial suppurating granulomatous lesions, 2 to 3 cm. in diameter and about 0.5 cm. in height above the surrounding skin. The right hand was greatly deformed; the tissues about the wrist swollen and infiltrated. There was loss of the phalanges of the index finger, so that the tip of the finger moved loosely on the end of the metacarpus, the tendons being contracted and the nail thickened and deformed. The condition suggested leprous deformity of the hand. The gross lesion can be well observed in the photograph.

In No. 234 is illustrated a case of leprosy which was studied by the writer in the Philippine Islands in 1899, in which leprosy bacilli were found at that

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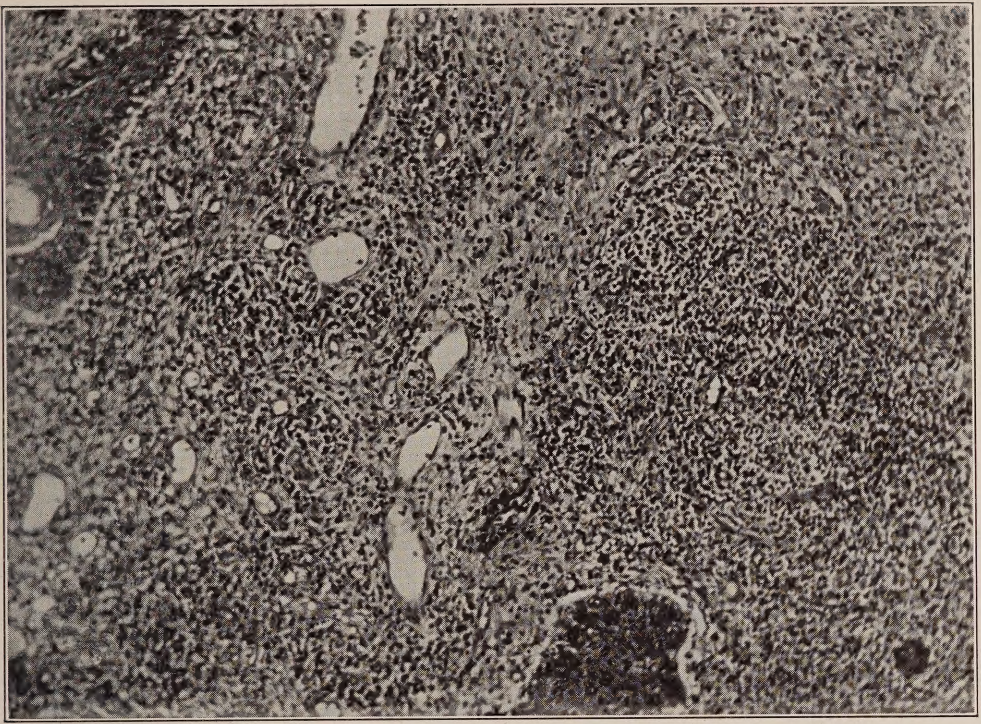
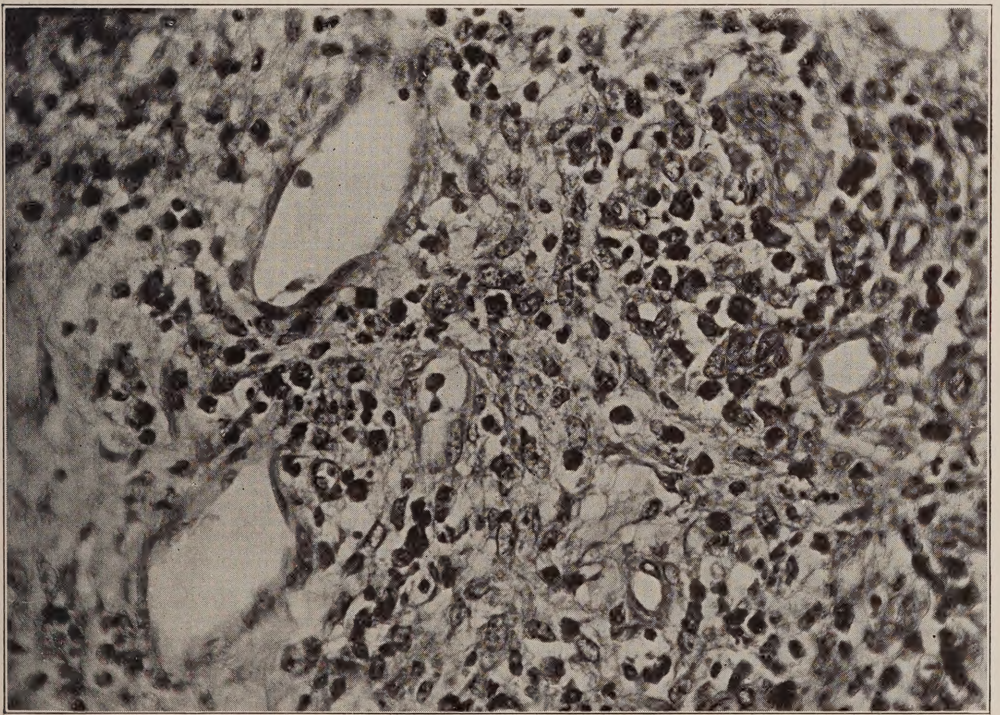
[1] Hallenberger: Beihefte, Arch. f. Schiffs-u. Tropen-Hyg. (1916), XX, 28.



No. 235. — Zeiss objective AA, compensating ocular 6



No. 236. — Zeiss objective DD, compensating ocular 6

Gangosa, photomicrographs of lesion of Case 531, showing pathological changes in the corium time. This Philippine case was some years later reported by one observer as a case of leprosy, and by another one as representing a tertiary lesion of yaws because the Wassermann reaction was positive. While in many cases of leprosy a positive Wassermann reaction is an evidence of existing syphilitic infection, unquestionably the Wassermann reaction occurs in a certain percentage of cases of leprosy in which the reaction cannot be rendered negative by antisyphilitic treatment. Hence in leprosy a positive Wassermann reaction may not necessarily be conclusive of syphilis or yaws. The recent work of DeVera [1] gives further confirmatory evidence of this statement. On the other hand, it is recognized that syphilis and leprosy may sometimes exist as concomitant infections.

Film preparations were made from Case 531 from the suppurative lesions on the arms, and portions of the diseased tissues and skin were removed and placed in Zenker's solution and ten per cent formalin. Sections were stained by the Ziehl-Neelsen-Gabbett method for acid-fast bacilli, by haematoxylin and eosin, Giemsa's solution and by Levaditi's silver impregnation method.

The three portions of tissue removed show some variations which, however, are not very marked. In the first portion of tissue, where the epidermis is preserved, the corneal layer is somewhat thin, while the stratum mucosum shows moderate proliferation. The papillae are irregularly placed but are, in many areas, still preserved. There is a marked cellular infiltration of the corium, in some instances extending into the papillae, but more marked in the deeper layers of the corium. The corium also is occupied particularly by proliferating fibrous tissue in which fibroblasts are numerous. The cellular infiltration is composed particularly of plasma cells and there are zones or islands made up almost entirely of these cells surrounded by fibrous tissue. Fair numbers of round cells are elsewhere scattered through the tissue but there are comparatively few polymorphonuclear leucocytes. The corium is rich in blood vessels and newly-formed vessels, and capillaries are plentiful. About some of the blood vessels there is moderate proliferation of the endothelial cells. The great majority of the vessels, however, appear normal. There is no marked evidence of endarteritis or thickening of the coats. In the areas where the epidermis has been destroyed, many round cells are present, but the polymorphonuclear leucocytes are not very numerous.

In the second portion of tissue, where the epidermis is intact, the corium beneath is represented by areolar connective tissue containing considerable fat. This tissue is very vascular. In these parts of the section there is no infiltration about the vessel walls and no evidence of either endarteritis or thickening of the coats. In many of these areas there is comparatively little infiltration with plasma cells. Near the areas where the epidermis is destroyed, the stratum mucosum shows hyperplasia and extensive downgrowths of the epithelium, almost suggesting conditions seen in early malignancy. These downgrowths of epithelium are surrounded by tissue densely infiltrated with plasma cells. In the area where the corium is exposed, the overlying tissues having been destroyed, coagulation necrosis has occurred. There are amorphous amalgamated areas of exudate staining red with eosin, in which there are cocci and the remains of a few degenerated pycnotic cells. Other areas show many polymorphonuclear leucocytes and degenerating cells.

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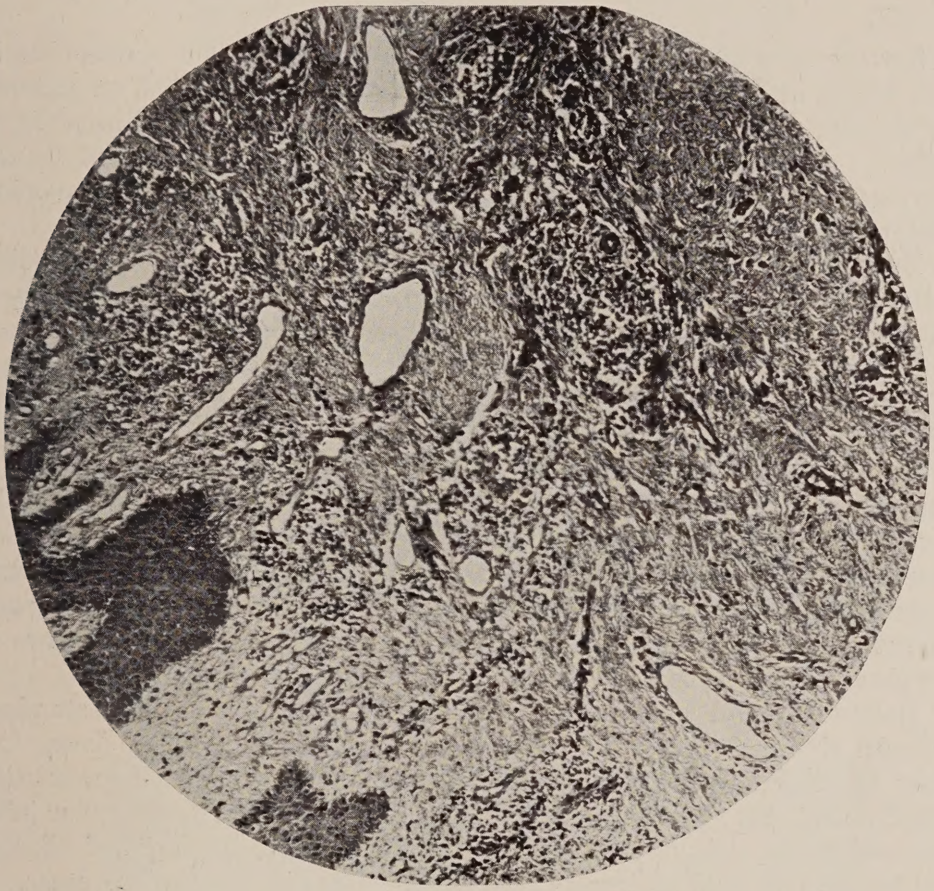
[1] DeVera: Jour. Philippine Islands Med. Assoc. (1929), IX, 318.

In the third portion of tissue removed, the only additional pathological condition is the presence, deep in the corium, of considerably denser fibrous tissue containing collagen fibers. In none of the sections were giant cells observed. The sebaceous and sweat glands and the hair follicles were retained and appear normal.



No. 237. — Photomicrograph. The numerous blood vessels do not show characteristics of syphilitic vessels. Their dilated condition is apparently due to the density of the tissue surrounding them. There is marked infiltration of the corium. (Gangosa)

While it was anticipated that acid-fast bacilli (leprosy bacilli) might be encountered in some of these lesions, none were found in any of the sections. No spirochaetes were demonstrated in the tissues by Levaditi's stain. While cocci were found on the surfaces of the suppurating lesions, neither spirochaetes nor fusiform bacilli were found. The histopathological condition present does not suggest leprosy, particularly, nor does it especially suggest syphilis, particularly in the absence of marked vascular changes. Modifications more or less characteristic of yaws were present, but all that can definitely be stated from the study of the histopathological lesions is that they give evidence in many respects of a chronic inflammatory condition in which there is a tendency to destruction of newly-formed tissue, with little tendency to invasion by micro-organisms from the air or from the surface of the skin.

Goundou

Several cases of goundou were observed in children. This disease has long been known in West Africa and was originally described in 1882, on account of the striking paranasal lesions, under the designation of the "Horned Men of Africa." A number of investigators who have more recently studied the question regard goundou as a late manifestation of yaws, or incline to such an opinion. However, not all do so.

Botreau-Roussel,[1] who made a most careful and extensive study of the disease in the Ivory Coast and published a monograph upon it in 1925, having observed 130 cases and operated upon 113, came to the conclusion that goundou is a manifestation of yaws. He excluded syphilis by the history in all but one case and points out that Schuffner's work shows the uselessness of serum reactions in the differential diagnosis of the condition. He admits, however, that the evolution of the osteitis, as he has seen it in his goundou patients, resembles exactly that seen in congenital syphilis, excepting only the paranasal tumors, which have never been described in syphilis, unless leontiasis ossea can be so considered. Twenty-eight cases of the total 130 showed marked glandular enlargement. Associated osteitis affecting both long and short bones was also frequently noted. Except for the bony deformations, other tertiary manifestations of yaws were not observed and no mention is made of juxta-articular nodules.

Botreau-Roussel and Cornil[2] studied from the histological standpoint, material obtained from eight cases of goundou occurring in the Ivory Coast. They concluded that the hyperostosis presents the general characteristics of syphilitic osteitis. The adjacent tissues show especially a perivascular infiltration and hyperplasia of the fibrous reticulum with fair numbers of fibroblasts and myelocytes, and an increase of collagen fibers in some of the areas. The inflammatory exudate consisted for the most part of plasma cells suggesting the condition commonly seen in "plasmome syphilitique" which, they remark, is especially characteristic of *Treponema* infections. They conclude that the paranasal outgrowths are not truly tumor formations but the result of an inflammatory hyperplastic osteitis in which there are changes in the bony trabecula and medulla comparable with those of syphilitic osteitis, the lesions being similar to those produced both by the *Treponema* of syphilis and the *T. pertenue*. They believe that their histological studies support the view of a framboesial origin.

Roy[3] who also studied 34 cases of goundou on the Ivory Coast examined histologically the paranasal tumors from two cases. The histological-pathological changes he describes coincide generally with those given by Botreau-Roussel

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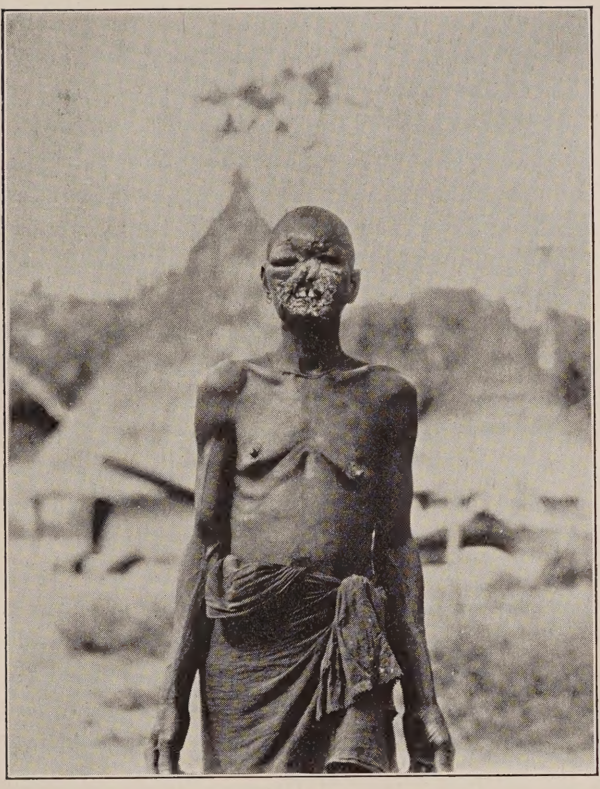
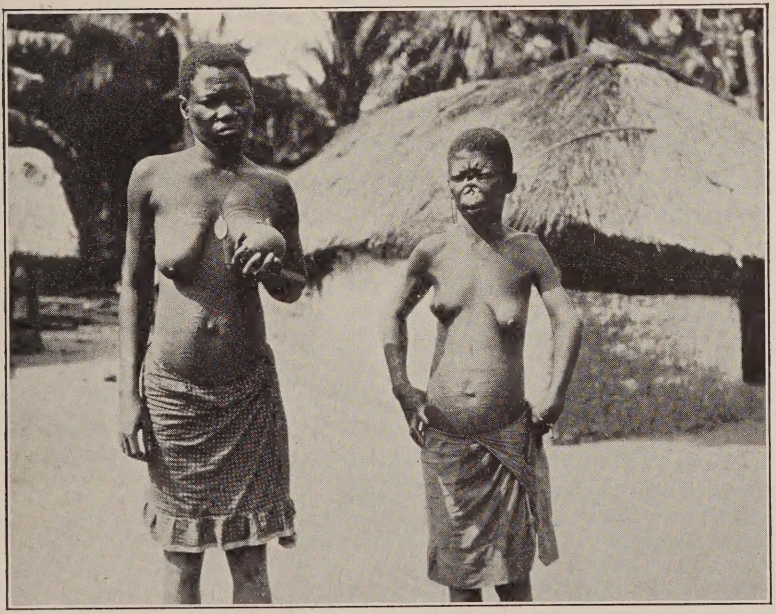
[1] Botreau-Roussel: Col. de la Soc. de Path. Exot., Paris, Masson et Cie., 20 Blvd. St. Germain, Paris (1925).

[2] Botreau-Roussel and Cornil: Bull. Soc. Path. Exot. (1924), XVII, 863.

[3] Roy: Rev. Méd. et Hyg. Trop. (1925), XVII, 33.



No. 238. — Gangosa, Case 386



No. 239. — Gangosa (right), Case 513; Elephantiasis, left breast, Case 514

and Cornil. No spirochaetes were found in the tissues especially stained for these organisms. Three somewhat oval bodies measuring 25 to 30μ were observed in one section, but their significance was not determined. In the cases which Roy studied clinically a generalized enlargement of the lymphatic glands was also common, often associated with an osteitis affecting both long and short bones. Roy, however, believes that the etiology of goundou is unknown and that he excluded both syphilis and yaws as etiological factors. Stannus,[1] however, who reviewed Roy's work, points out that there was a history of yaws in many of Roy's cases and a very great deal of evidence presented by Roy showing that goundou is a manifestation of yaws. Roy apparently believes that the goundou-like affection which has been described as occurring in monkeys is a similar condition to that which occurs in man.

McNaughton,[2] Moore,[3] and Chesterman[4] are all in favor of the fact that goundou is a tertiary lesion of yaws. McNaughton reports a case of a boy aged ten years with a typical paranasal swelling. The child had suffered from yaws two years before, while the paranasal swellings appeared a year later. No treatment had been given for yaws. Neither the patient nor his father and brother, who both had yaws, showed any manifestations of syphilis. The patient was given two injections of Bis. Sod. Tart. with Soamin at an interval of a week, but with no improvement. Moore has reported a typical case of goundou which at the same time showed "sabre tibiae," serpiginous yaws, ulceration in the nose, and complained of nocturnal bone pain. The paranasal tumors were removed by operation and the general condition of the patient was said to improve after a long course of salvarsan.

Chesterman has also reported a case of a girl aged twelve who suffered from yaws with a well-marked general eruption for four years before. The swelling of the nose was noticed for the past two years. The condition of the nasal bones was associated with the periostitis of proliferating type on the mandible to the left of the point of the chin, and also with very well-marked "sabre tibiae," both conditions appearing concurrently with the goundou. He remarks that anterior posterior bowing of the tibiae is one of the commonest bony lesions of tertiary yaws in his district. The goundou swellings in his case were removed by operation and the patient made a good recovery, aided by injections of neosalvarsan.

Pasqual,[5] Carroll[6] and Araujo,[7] however, do not regard goundou as a tertiary manifestation of yaws. Pasqual points out that it has not yet been established that yaws and goundou are of common origin. There was no history of syphilis or of yaws in his patient or other members of the family in a district said to be yaws-free. After searching inquiry regarding the history it appeared that small swellings about the size of a pea were noticed on the bridge of the nose by the parents at birth. Pasqual believes that the case was congenital. Roy also referred to the possibility of the condition being congenital. Araujo, who has observed six cases of goundou in Brazil, also states that there was no evidence of yaws in any of his cases. Sharpe [1] has recently reported a case as apparently identical with goundou in a white man aged forty-three who had always resided in London, and in which there was a strongly positive Wassermann reaction. It is stated that the patient had not suffered from yaws but that he had had syphilis. It is also noted that antisyphilitic remedies made no impression on the lesions. Carroll [2] has also called attention to a case diagnosed as goundou in which the lesion was unilateral on the left side of the nose. The blood test was positive for syphilis (Meinicke's test). He was given six doses of neosalvarsan, 0.6 gram each, and iodide of potash in increasing doses for one month, without any noticeable change in the size or consistence of the tumor. There was a history of injury in this case four years previously.

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[1] Stannus: Trop. Dis. Bull. (1925), XXII, 650.

[2] McNaughton: Trans. Royal Soc. Trop. Med. and Hyg. (1926), XX, 310.

[3] Moore: Nigeria Ann. Med. and San. Reports (1925), Ap. D., p. 58.

[4] Chesterman: Trans. Royal Soc. Trop. Med. and Hyg. (1926–1927), XX, 554.

[5] Pasqual: Trans. Royal Soc. Trop. Med. and Hyg. (1928), XXII, 59.

[6] Carroll: 16th Ann. Report, United Fruit Co., Medical Dept., Boston (1927), p. 165.

[7] Araujo: Bull. Soc. Path. Exot. (1928), XXI, 387.

Manson-Bahr [3] has recently reported a similar condition that has been observed in the higher apes, especially the chimpanzees, and points out that a good example was to be seen in one of these anthropoids in the Zoological Gardens of London. Hanschell [4] also mentions the occurrence of goundou in a *Cynocephalus* monkey at the Seaman's Hospital in London. This animal became savage and had to be killed. Hanschell macerated the tissues of the skull and thus uncovered a hard, bony tumor, obviously starting from the socket of the canine tooth.

Bouffard,[5] Marchoux and Mesnil,[6] Ziemann,[7] and Seques [8] have also reported upon goundou in the monkey, chimpanzee, and gorilla, and have made histological studies of the condition. Mouquet [9] has reported recently upon a condition resembling goundou in *Cercocebus aethiops*. He is inclined to consider the disease as an osteomalacious condition to which the generally bad conditions of life in captivity may predispose. He suggests that the etiology of the goundou of man and of the ape may be different. Balfour [10] has also referred to lesions in a circus pony encountered on the steamer from Mauritius to Bombay, which in their site, general appearance and consistence suggested goundou. Ziemann does not consider that the proof has yet been brought that the condition, either in man or monkey, is a tertiary manifestation of framboesia.

We had no opportunity to remove or study these nodules in the African cases we observed clinically.

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[1] Sharpe: Trans. Royal Soc. Trop. Med. and Hyg. (1928), XXII, 293.

[2] Carroll: 16th Ann. Report, United Fruit Co., Medical Dept. (1927), p. 165.

[3] Manson-Bahr: Brit. Jour. Ven. Dis. (1928), IV, 50.

[4] Hanschell: *Ibid.*, 67.

[5] Bouffard: Bull. Soc. Path. Exot. (1909), II, 216.

[6] Marchoux and Mesnil: Bull. Soc. Path. Exot. (1911), IV, 150.

[7] Ziemann: Abhandlungen aus dem Gebiet der Auslandskunde, Hamburg (1927), XXVI, 618.

[8] Seques: Rev. Méd. et Hyg. Trop. (1929), XXI, 50.

[9] Mouquet: Bull. Soc. Path. Exot. (1929), XXII, 918.

[10] Balfour: Trans. Royal Soc. Trop. Med. and Hyg. (1928), XXII, 295.

XXII

LEPROSY AND COMPLICATING INFECTIONS

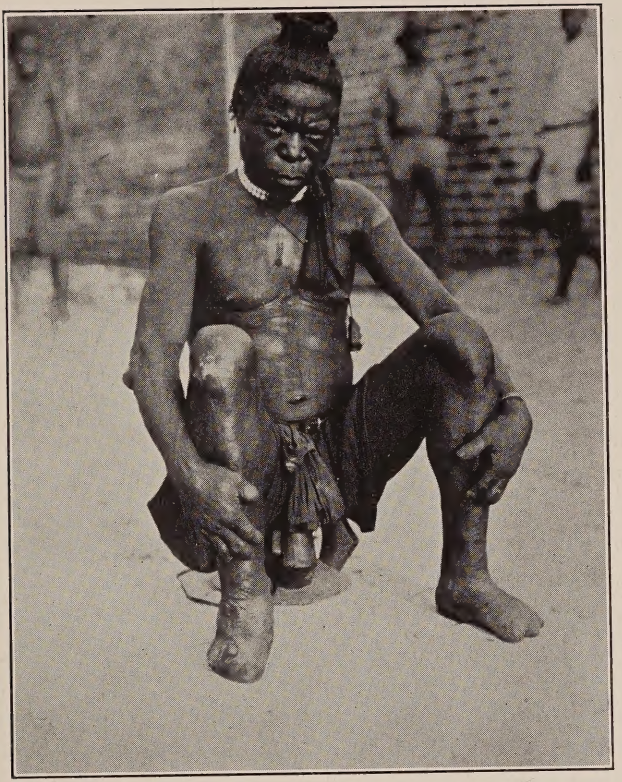
Leprosy is common in Liberia, both in the interior and on the coast, as well as in the Central Congo. Cases could be found in most of the villages of Liberia. No attempt, of course, is made to isolate the patients throughout Liberia or in parts of the Congo where individuals with leprosy mingle freely with the other inhabitants of the villages.

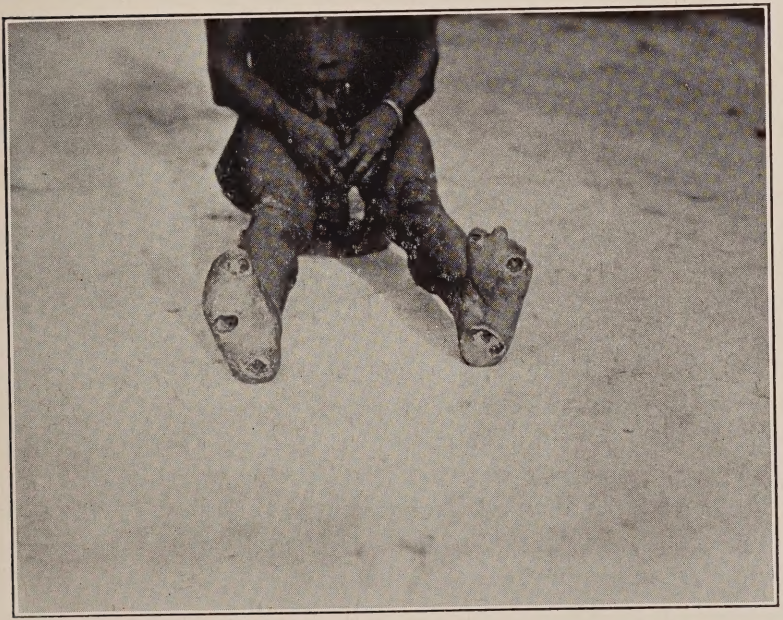
The trophoneurotic form was more common in Liberia than the nodular or tubercular. While usually the disease in Africa offered no difficulty in diagnosis, in some cases the diagnosis was made with very great difficulty. In a number of instances we observed the loss of one or more toes in individuals in whom the condition could not always be explained satisfactorily as the result of ainhum or of some injury. Such lesions sometimes suggested that they were the result of leprosy. However, in some instances, even where the ends of the toes were granulomatous, no acid-fast bacilli were found in film microscopical preparations, while in other similar cases leprosy bacilli were discovered. The absence of leprosy bacilli in such cases, if the lesions are purely trophoneurotic, does not exclude leprosy.

It may be recalled that Zambaco believes that all uncommon mutilations, such as ainhum for instance, are forms of leprosy, though he has given no proof of this hypothesis.

In a number of instances, particularly in Liberia, the disease seemed to have reached a quiescent or arrested stage. One might have expected to see among a number of Liberian tribes a greater number of cases of more advanced leprosy than we did, and not so many with arrested forms of the disease. Such a condition can, perhaps, sometimes be explained on the ground that leprosy is a very chronic disease and that numbers of these people have gradually developed or acquired a tolerance or immunity against the infection. Obviously their improvement or recovery has not depended on any treatment or upon favorable hygienic conditions.

Among the readily recognized cases of leprosy, the nodular type predominated, and in them there was no difficulty in demonstrating the *Bacillus leprae* (No. 246). Many of these patients also showed ulcers with spontaneous amputation of toes or fingers and areas of anaesthesia. Still others had nasopharyngeal lesions indistinguishable from gangosa or extensive scarring like that seen in tertiary yaws or n'gonde. In such cases, it seemed not unlikely that the entire picture was produced by a combination of leprosy and treponemiasis. In some instances the evidences of treponemiasis were most striking, but the patients also showed features suggesting leprosy. Cases 531 and 385 are in-





Nos. 240, 241. — Leprosy, Case 570, destruction of fingers and toes, and perforating ulcers of soles of the feet stances of this nature and are mentioned because they have already been referred to in the discussion of treponemiasis and gangosa.

Another group of cases with macular leprosy showed circinate or serpiginous lesions of the skin which somewhat resembled tertiary syphilides. The lesions were sharply defined and bordered by small and slightly elevated papules of a reddish color. In some instances the epidermis over the papules was scaly, and in others smooth, and showed either increase or decrease of pigment. In several of such cases no evidence of anaesthesia could be obtained. Still other skin lesions of leprosy suggested trichophytosis or blastomycosis of the skin.

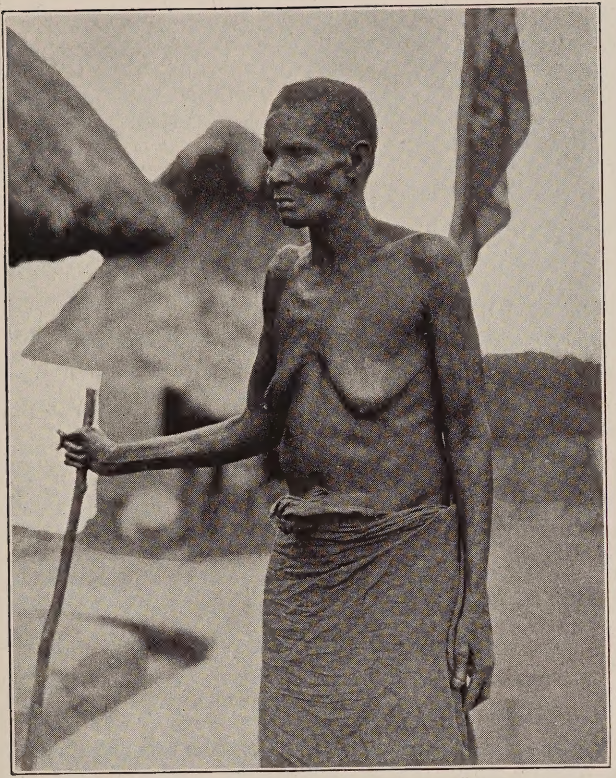
Sometimes, in parts of Africa, it was difficult without recourse to microscopical examination, to distinguish some of the *Trichophyton* infections from the lesions of nerve leprosy. Patches, on the trunk in adult negroes, afflicted with nerve leprosy, consisting of slightly raised and itching rings or large segments of rings with some scaling, may be particularly confusing and sometimes may, from their appearance alone, suggest *Trichophyton* infection. Especially if such leprous lesions of the skin are secondarily infected with blastomycosis may they cause difficulty in diagnosis. Photograph 245 illustrates very well a case with such maculocutaneous lesions. However, the diagnosis of leprosy in this case should be obvious from the inspection of the lesion alone.

The clinical diagnosis of leprosy is an art in which proficiency depends upon experience and knowledge gained from observation of the various manifestations of the disease in many cases in different parts of the world, rather than upon familiarity with the written description of the lesions. Indeed, the diagnosis of leprosy sometimes can be made more correctly from the clinical appearances of the condition than from a microscopical examination of scrapings of the lesions.

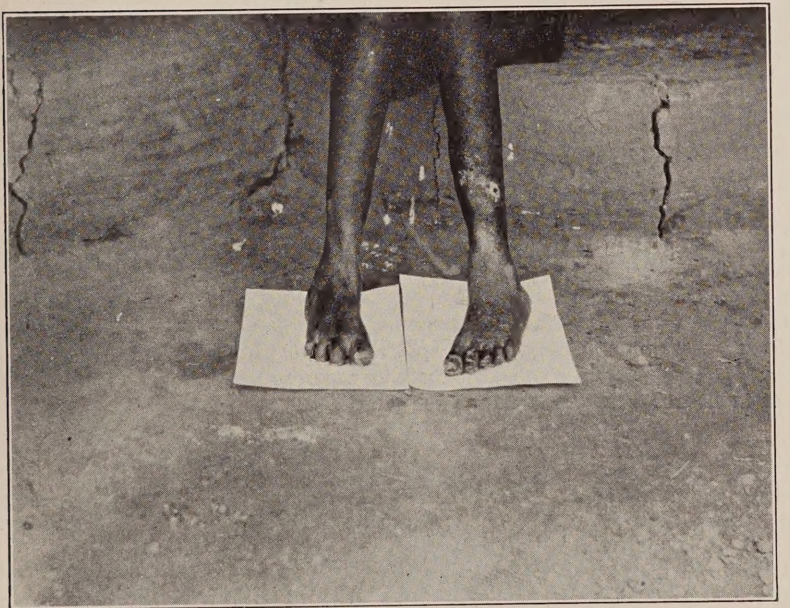
Blastomycosis and Leprosy

Case 110 was one in which the diagnosis was especially difficult because the examination of the microscopical preparations made with material obtained not only by superficial scraping of the skin but also by deep scraping, showed always numerous *Blastomyces* and no leprosy bacilli.

In view of the difficulty of the diagnosis in this case, it is considered of importance to refer to the clinical manifestations in detail. The patient was a young man, probably from 23 to 25 years of age, a member of the Kpwesi tribe, apparently in robust condition, and served us for a time as a porter. He, however, was apprehensive of the cutaneous lesions upon his face and trunk and desired treatment for them. The lesions occurred upon the face, particularly on the forehead, cheeks, and chin. The alae of the nose, the lips, ears and the neck were free. Those on the face consisted of slightly raised plaques measuring from 5 mm. to about 2 cm. in diameter and 1 to 2 mm. in height. One or two of the smaller plaques were circular in outline. The remainder were more irregular and their borders merged gradually with the normal skin. On the trunk, the lesions were distributed particularly over the shoulders, chest, abdomen, and arms. They were not distinctly visible on the forearms and back. They were also present on the thighs and buttocksand posterior surface of the legs. On the trunk, arms,



No. 242. — Cutaneous lesions of trunk



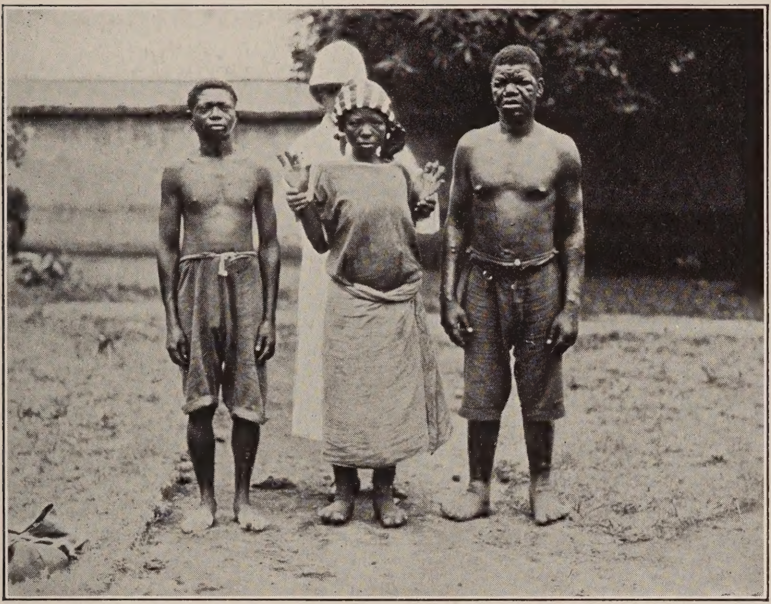
No. 243. — Partial destruction of toes
Anaesthetic leprosy, Case 380

and legs they consisted of more or less circular patches measuring from about 1 cm. to 7–8 cm. in diameter. Here again the smaller ones were roughly circular while the larger ones had irregular, indefinite margins. The patches on the trunk, arms and legs were not raised and were smooth to the touch. They were distinctly lighter in appearance than the surrounding skin and of a cinnamon or copper color. Examined with a hand lens, the surface of the lesions on the face appeared uneven, apparently due to protrusion of the closely-placed papillae, while those on the body were even. The lesions, particularly those on the forehead and face, suggested leprosy.

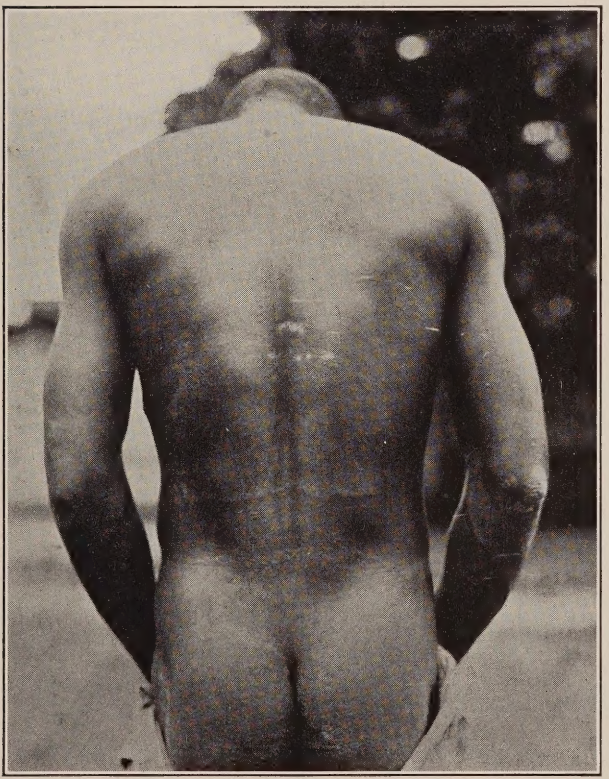
After scrubbing the skin over a lesion on the cheeks with gauze and alcohol, it was scraped with a scalpel, and film preparations made with the material thus obtained which were stained for acid-fast bacilli. No leprosy bacilli were discovered but many oval and budding forms of *Cryptococcus* or *Blastomyces* were found lying both free and within the epithelial cells. In view of the fact that no leprosy bacilli were found in several such examinations, the skin over the cheeks was again scrubbed with gauze and alcohol and an alcohol dressing applied for five minutes, after which a small piece of the skin with the subcutaneous tissue was removed. Microscopical preparations made from the cut surfaces of this tissue showed only blastomyces and again no leprosy bacilli. The tissue was placed in Zenker's solution. Cultures were taken on Sabourraud's medium from the cut surfaces of the piece of tissue removed. The following day after a similar cleaning with alcohol six microscopical preparations were made from the maculae on the chest, and these were studied with similar results. An examination of the patient's blood was negative for parasites, but there was apparently a moderate increase in eosinophils. On the third day, a distinct growth was visible in the culture, and on microscopical examination a few budding yeast cells were seen, but a large, coarse bacillus, very probably a contamination from the air, was present in large numbers. The latter organism rapidly overgrew the whole surface of the culture. Four days later another examination of scrapings of portions of other lesions was made for leprosy bacilli, but only the yeast cells were encountered. Cultures also were again made from the lesions. At this time the following clinical note was made:

> The diagnosis of the case is frankly a puzzle. Without any microscopical examination, it would have been regarded as one of leprosy. It must, however, be admitted that the lesions on the skin of the face are not tubercular in character and they are not indurated to the touch. On the body, the patches of cinnamon red color are paler than the brown normal skin surrounding them, and are smooth. Upon the face, some of the patches are even lighter in color. There are no lesions in the nose or mouth or about the ears, and no anesthesia can be detected.

After a few days, the cultures in Sabourraud's medium revealed a white, porcelain-like growth which showed upon microscopical examination many oval and budding or dumb-bell-shaped forms and also chains of three or four budding segments, but with no mycelium. These yeast cells did not show a distinct double contour and also there were very few granules within them, and these were of small size. The organism was apparently a *Cryptococcus*, but obviously quite different from the *Cryptococcus farciminosus*, which was first described in a



No. 244. — Anaesthetic mutilating and tubercular forms of leprosy, Cases 495–497



No. 245. — Cutaneous lesions of nerve leprosy, Case 495

human lesion of the skin in a case in the Philippine Islands.[1] It obviously is also different from the *Cryptococcus dermatitis* of Gilchrist and Stokes, as is evident from its morphology (Nos. 252–255). It evidently is a parasite of epithelial cells and is not present in endothelial phagocytes. It was not possible to identify further the species at the time in the field, and in the later months of the Expedition the tubes became extensively contaminated with other fungi from the air, from which it could not be recovered.

Castellani,[2] in his excellent monograph upon "Fungi and Fungous Diseases" has fully discussed the etiology and clinical varieties of blastomycosis and gives descriptions of twelve species and also mentions fifteen other less known ones. The organism in the present case is perhaps identical or closely related to *Blastomyces* or *Cryptococcus epidermidis* which was isolated and described by Castellani some years ago in Ceylon, and later cultivated by him from small, roundish, dirty yellow or brown patches of skin on the arms and, more rarely, on the chest or neck. In Castellani's cases the invasion of the epidermis by the microorganism was apparently more superficial.

Our case could not be studied further since unfortunately the patient did not reappear. At the last examination, additional portions of tissue were removed and these, as well as the other pieces previously taken, were hardened in Zenker's solution and in formalin, and upon our return to the United States were sectioned. The sections were stained by different methods, including Giemsa's and the Ziehl-Neelsen-Gabbett method for acid-fast bacilli. In the study of the sections, while the cryptococci were still encountered in the cells in the epidermis, being found in all layers of the stratum corneum and in portions of the stratum mucosum, deeper in the corium, leprosy bacilli were found in fair numbers (No. 256). Although in some portions of the tissue leprosy bacilli were easily demonstrable, in other parts of it they were not discovered. Both the clinical and histological examinations of this case suggest that the leprosy infection was making very slow progress; also, there had been evidently superimposed upon it the epidermal infection with *Cryptococcus*. Whether the alterations in the skin produced as a result of leprosy, predispose it in such areas to secondary infection with *Cryptococcus*, it is not possible to say.

Several other instances of somewhat similar nature presenting yellowish-brown or copper-colored maculae or spots, usually upon the trunk, were later observed in Liberia. In two cases (183 and 219) the maculae were observed both upon the face and trunk. The patches were usually slightly elevated, especially at the margins, the skin over them being smooth. No anaesthesia could be detected. In one of the cases (219) on the under surface of the great toe an ulcer was present having a base of relatively healthy granulation tissue. The tip of the toe was entirely gone. There was no anaesthesia of the skin of the toes, no enlargement of the ulna nerve, and the lobes of the ears were normal. There were also no nodules in the skin. The lesions on the trunk in this case are well

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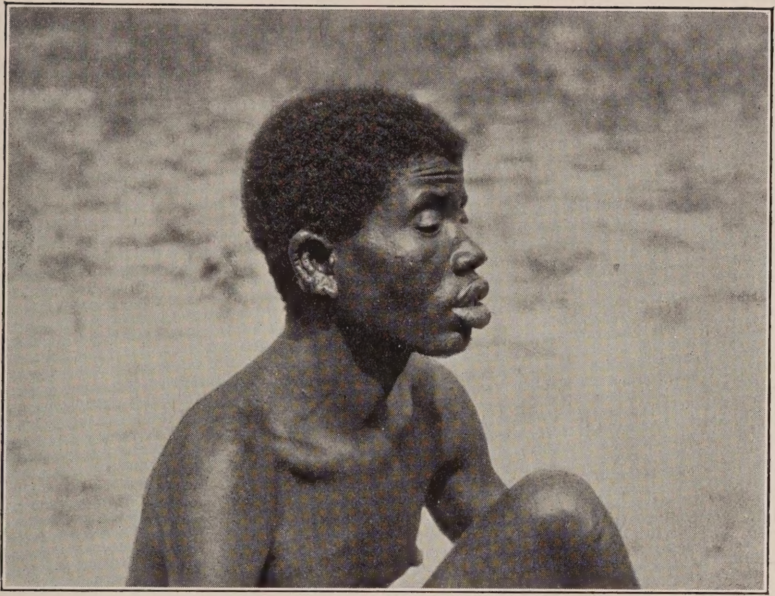
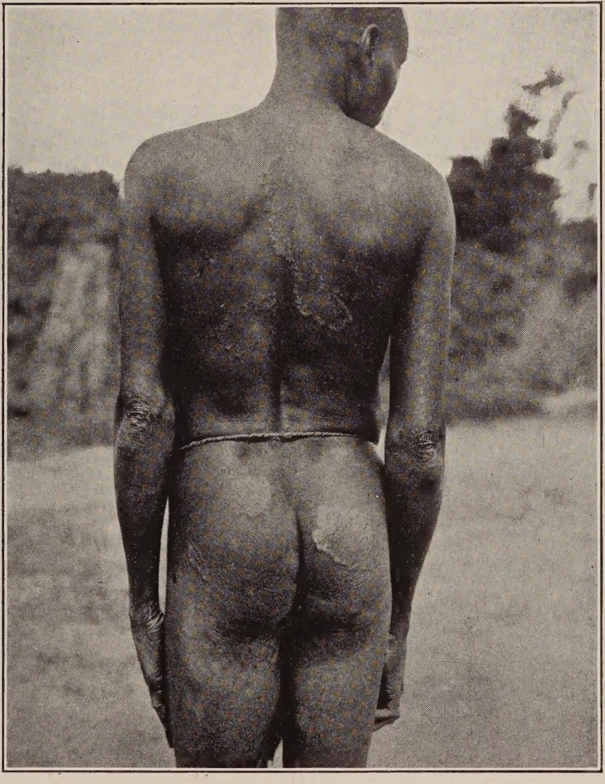
[1] Strong: Publications, Dept. of the Interior, Bureau of Govt. Laboratories (1902), No. 1; Trans. Assoc. Amer. Physicians (1905), XX, 383.

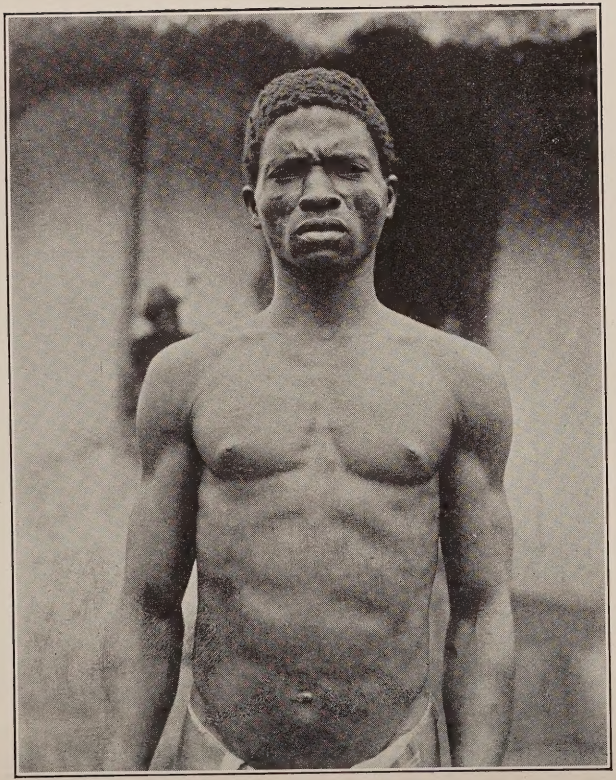
[2] Castellani: Arch. Derm. and Syph. (1927), pp. 388, 571, 714; (1928), pp. 61, 194, 354.



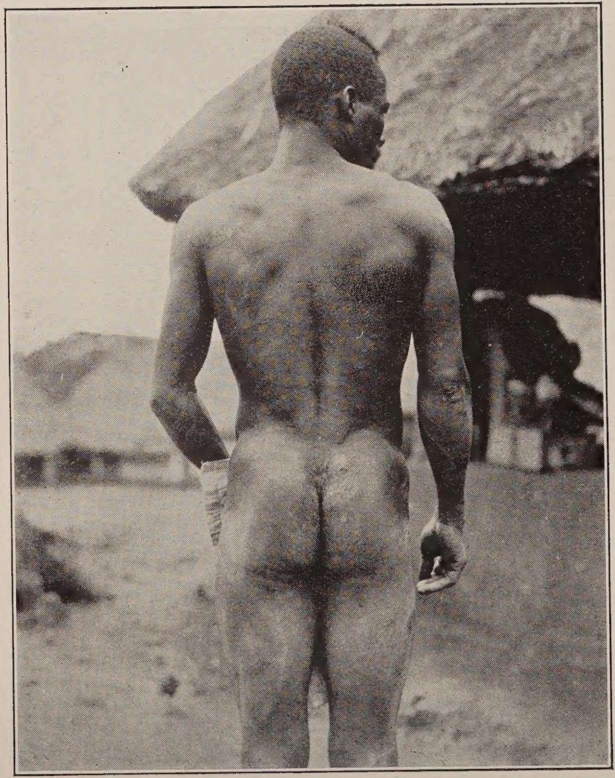
No. 246. — Tubercular leprosy, Case 406; leprosy bacilli in scrapings from the ear



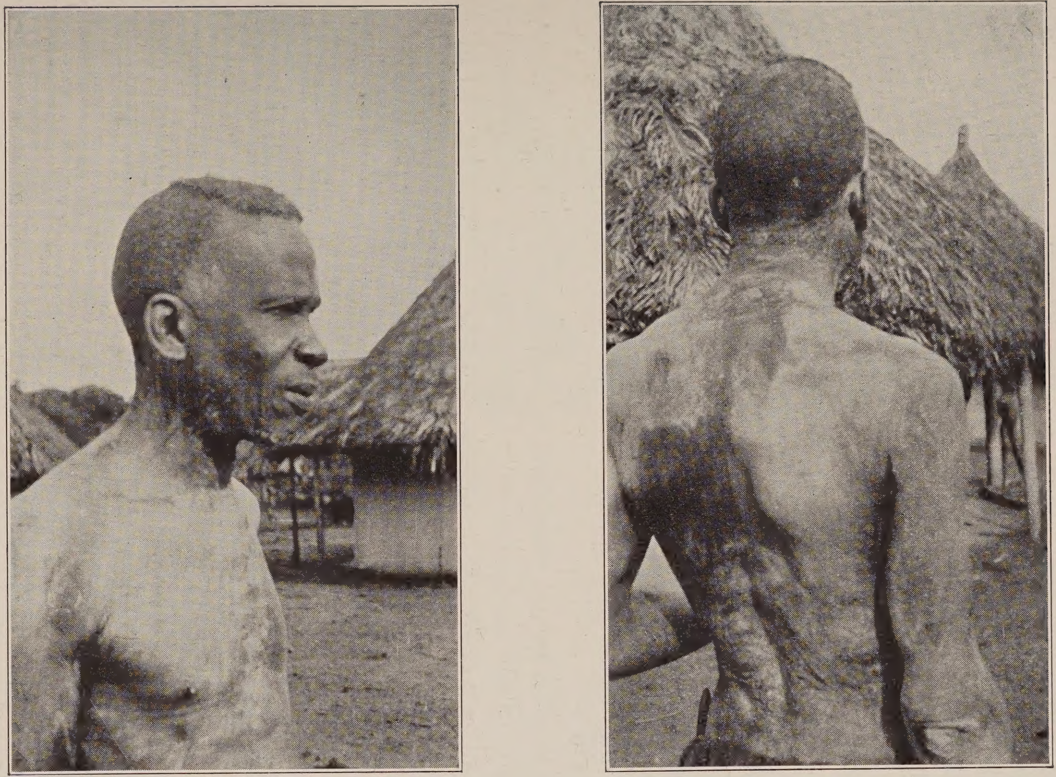
No. 247. — Anaesthetic leprosy, cutaneous lesions, Case 400



No. 248. — Blastomycosis and leprosy, Case 110



No. 249. — Blastomycosis and leprosy, Case 219



Nos. 250, 251. — Case 183

illustrated in the photographs. The patches over the back and shoulders show serpiginous margins, slightly raised, of a reddish copper color, lighter than the surrounding skin. In the different cases of similar nature these maculae varied in size from 3 to 4 cm. up to 15 cm. in diameter (see Whitman, page 1052).

Tissues were taken from the cutaneous lesions and hardened in Zenker's solution and in formalin. Examination of scrapings from the patches showed large numbers of cryptococci similar to those already described in Case 110. In the study of the sections of three of the cases, however, no leprosy bacilli were found in the lesions. Nevertheless, they were almost certainly cases of trophoneurotic leprosy. Leprosy bacilli are, of course, frequently not found in many of the skin lesions of trophoneurotic leprosy, as we have emphasized elsewhere. It may be recalled that in some instances the skin lesions of leprosy consist of light or brown maculae in which there is distinct cellular infiltration of the skin. Such lesions probably constitute a stage of tubercular leprosy. In many of them, however, the pathological process apparently becomes arrested and the infiltration of the skin largely disappears. While in the earlier infiltrated lesions of the skin in tubercular leprosy, bacilli are usually found without difficulty, in the older maculae and particularly in the maculae associated with lesions of the nerves, the organisms are very frequently not found. In such cases, however, they may sometimes be found in the involved nerves supplying the skin area.

Relationship of dermal moniliasis to leprosy. E. C. Smith [1] has recently described a form of dermal moniliasis in Lagos, Nigeria, which may be similar to the condition that we observed in Liberia and have referred to. In his cases, the portion of skin most frequently involved was found to be that over the scrotum. However, the condition that he found, consisting of scaly maculae over the scrotum was not observed by us. Smith, however, also observed patches scattered over the trunk and limbs. These varied in size and shape. Large irregular areas had ensued from the confluence of smaller ones. They were usually very scaly and tended to become whiter when scraped. A second clinical variety was described in which areas were somewhat shiny and like much-creased silver paper with hard and very scaly patches. The condition appeared to him to closely resemble that produced by the seborrhoea of temperate climates. Also, the close clinical resemblance to the various forms of tinea, in many instances rendered the naked eye differentiation of the etiology difficult if not impossible. It is the appearances illustrated in the excellent photographs in Smith's article of the lesions of the body, and of the micro-organisms observed, that suggest particularly that the condition may be similar to the one that we studied in Liberia. We, however, did not see lesions which were particularly scaly or psoriasis-like in appearance. Possibly, however, the habits of the different tribes with reference to bathing and scrubbing the skin may account somewhat for this difference in scaliness. Smith describes the organism he encountered as a *Monilia*. The morphology of the yeast cells which he found in his film preparations and in sections is similar to that observed in the Liberian cases.

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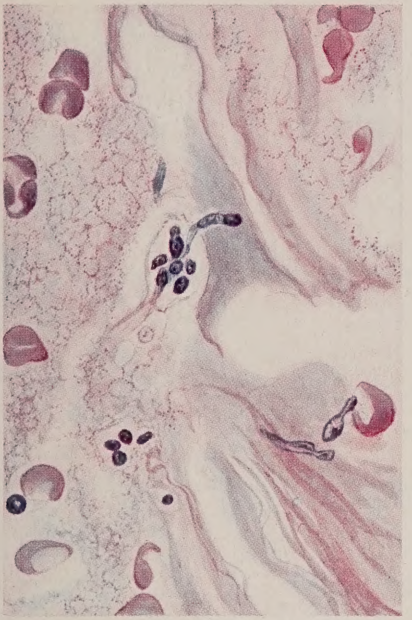
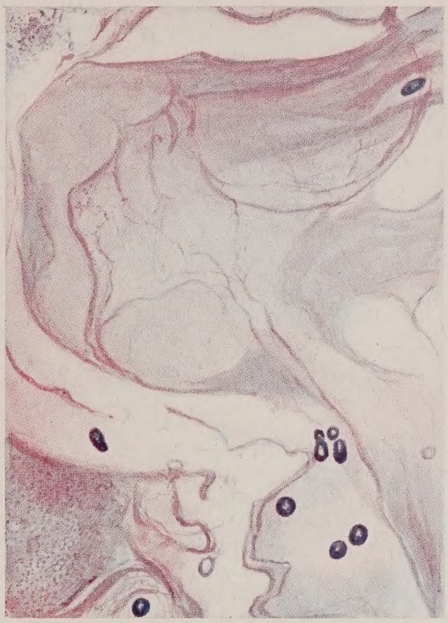
[1] Smith: Trans. Royal Soc. Trop. Med. and Hyg. (1927), XXI, 125.



No. 252



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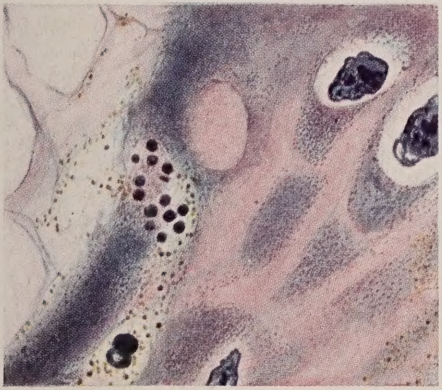

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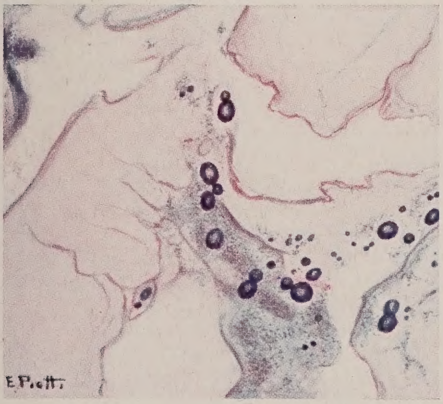

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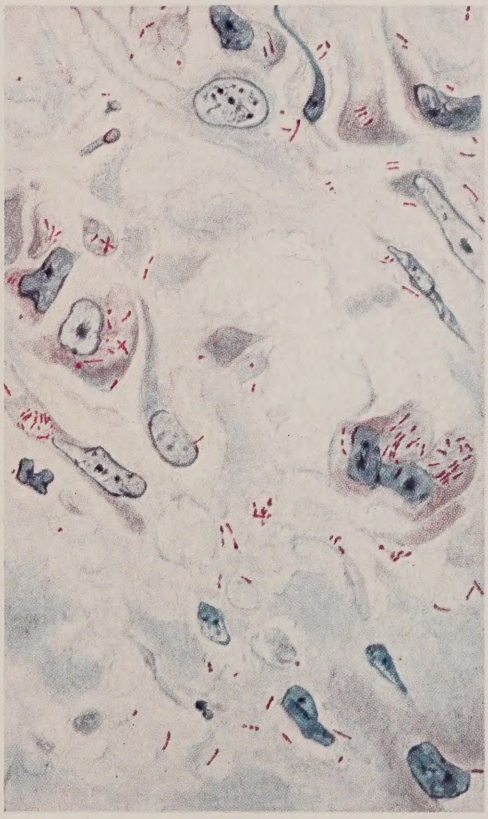

No. 256

Nos. 252–256. — Camera lucida drawings (Zeiss objective 2 mm., compensating ocular 6)

Nos. 252–255. — Blastomyces in the epidermis

No. 256. — Leprosy bacilli in the corium

In a later publication, he [1] notes the occurrence in a number of patients of a condition peculiarly akin to maculo-anaesthetic leprosy. He points out that the resemblance is not a slight one, as is borne out by the fact that the natives affected with this condition are reported as lepers by their associates. Many of them, too, seen for the first time in the out-patient department, he says, are regarded with suspicion and labelled "query leprosy." Those affected are in the main young male adults, enjoying apparently perfect health. Areas of the skin involved may be single or multiple, usually asymmetrical and situated on the face, back, abdomen, or upper limbs. A typical patch is seen to be distinctly lighter than the surrounding normal skin, being of a characteristic brownish-yellow tint. The outline is commonly serpiginous or gyrate in character, but ringed or plaque-like areas also occur. In these latter, the central parts are smooth and are evincing a tendency to return to the normal pigmented condition, whereas the periphery is raised and presents features in common with the gyrate or serpiginous forms. The skin in such an area is definitely raised and infiltrated, the infiltration being papular in nature. These papules are flattened and present a smooth, almost shining or polished surface. Scaliness may be present to a very slight degree. The condition is very chronic and never tends to ulceration unless superadded infection with pathogenic organisms intervenes.

For the differentiation from leprosy, Smith used the examination of a piece of the involved area and the test for anidrosis. For the latter he injected intracutaneously or subcutaneously a few drops of a solution of pilocarpine nitrate. He says that the appearance of sweat, in the form of minute drops, to approximately the same extent in a diseased area and a normal area of the skin, is strong evidence that the condition is of a non-leprotic character. He admits, however, that anidrosis of itself must not be regarded as certain evidence of leprosy.

In the study of the histological preparations, including stains for acid-fast bacilli and Levaditi's method, he found that the superficial epithelium showed but little change except in the region of the hair follicles. Many of these appeared to be markedly distended with degenerate masses of hyalinised material, presumably derived from the horny epithelium. The sebaceous ducts, as they enter the hair follicles were also involved. In many of the follicles so affected, the hair was present in the center of the distended follicle and was surrounded by a dense layer of "bottle bacilli." He remarks that they might be confused with *Monilia*, but their variation in size, the typically ovoid or flattened shape, the absence of any mycelial elements, and the fruitless attempts at cultivation on the ordinary media, all helped to apprise him of their true nature. Scanty "bottle bacilli" occurred scattered throughout the hyalinised material and also in a few of the sebaceous gland ducts as they open into their respective follicles. He found that it was in the earlier lesions that the histological changes could be best studied. Where some of the affected hair follicles were cut through in their deeper portions, the hair was seen to be lying eccentrically, the hyaline material occupying the follicle as a plug. Many of these plugs showed a faintly-staining amorphous or granular central area and contained numerous slender gram-positive bacilli

[1] Smith: West Africa Med. Jour. (1928), XI, 91.

("acne bacilli"). In other sections, masses of a gram-positive coccus were found in the plugs. Hyperkeratosis and parakeratosis of the stratum corneum was common in the region of the hair follicles. As regards the corium, the infiltration was strikingly nodal in type. Subsequent fusion of these nodes or tubercle-like lesions resulted in the formation of irregular areas. The infiltration was most marked around the hair follicles and corresponding sebaceous glands. In some of the cases examined, the sweat glands were markedly involved. He thought the involvement of sweat-units probably explained why the pilocarpine test failed to evoke a reaction in some of these cases. With reference to the nature of the inflammatory reactions, he points out that a striking feature is the presence in considerable numbers of well-defined giant cells which persist in the more chronic areas but are not so numerous. The fundamental lesion appeared to be a tubercle-like collection of cells. These component cells were spindle-shaped, with elongated or vesicular, faintly-staining nuclei, and were probably derived from endothelium. The whole bore a close resemblance to a somewhat oedematous tubercle. Later, lymphocytes, polymorphonuclears and mast cells were involved in the reaction. Plasma cells were scanty. In the older lesions the round cells predominated, the infiltration becoming denser and more compact in character. Considerable congestion of the capillaries was present, both the capillary and lymph spaces being rendered more distinct by their hypertrophied lining endothelium. The infiltration extended right up to the epidermis, the narrow separating layer of corium, so typical in leprosy, not being present. Examination for acid-fast bacilli and for spirochaetes was negative.

Smith regards the cases as being non-leprotic on account of the clinical history (prolonged duration with but scant progress of the lesions); absence of acid-fast bacilli; absence of anidrosis in many of the cases; and the histological appearances. He thinks it of more importance to draw attention to the non-leprotic nature of the lesions than definitely to label the condition, and says that possibly it is a form of acne or of lichen, or that seborrhoea in one of its many guises may be a factor, and syphilis and yaws possible predisposing causes. Therapeutic measures appear to have little or no effect.

Smith's observations are of very great importance and further studies of this nature should be made. While there is apparently, from his investigation, no question that the histological picture is partly produced by the infection he describes, in view of the difficulty we have often had of finding leprosy bacilli in the skin in the neurotrophic forms of the disease,[1] in other countries as well as in Africa, we believe that leprosy cannot be excluded by the negative bacteriological examination in such cases. The question arises whether leprosy in more or less quiescent form may not also be present in at least *some* of the cases which Smith refers to. He gives very excellent photographs. Our recollection is that in two of these the lesions illustrated very closely resemble the maculae of leprosy.

Also, his description of the histological picture is in part very similar to the condition sometimes observed in the older skin lesions in maculo-anaesthetic leprosy.

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[1] Strong: Diagnosis of Leprosy, "Bedside Diagnosis," ed. by George Blumer (1928), I, 176–180.

XXIII

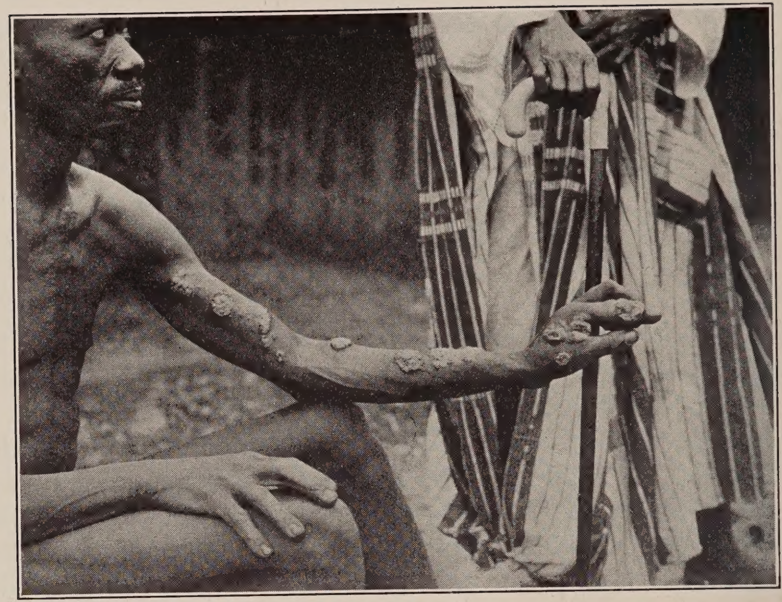
DISEASES AFFECTING THE SKIN

SPOROTRICHOSIS

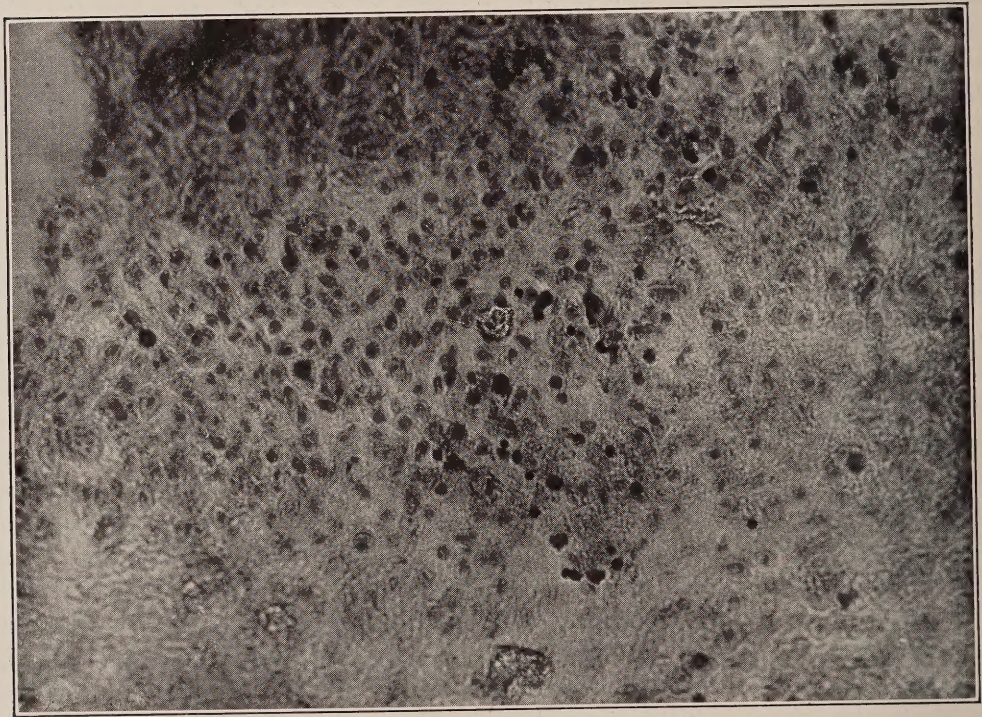
In Liberia a case of sporotrichosis was observed. The patient was a member of the Jarquellis tribe, about 45 years of age. The duration of the disease was said to be one year and to have started on the finger and spread up the arm. No similar cases were said to have occurred in his house. The general condition of the patient was good. The right forefinger was much swollen, especially around the phalanx. On the dorsal surface was an ulcer about three centimeters in diameter. The base of the ulcer was formed of granulomatous tissue in which there were depressions covered with a thin grayish slough. There was a similar lesion of smaller size between the thumb and forefinger and still smaller ones over the first and second metacarpal bones. Distributed along the radial surface of the forearm were four more somewhat larger lesions and there were also three on the inner aspect of the forearm. These ulcers were crater-shaped and had elevated margins. All the lesions were covered with a crust which was easily washed or picked off. There were no lesions of this nature elsewhere on the body and no scars which suggested that a similar process had existed elsewhere. There was, however, an old scar with keloidal thickening on the right hip, and another scar over the head of the right fibula. The skin sensation was apparently normal on the arms and back. The lesions are well illustrated in No. 257 (Case 186).

An examination of the peripheral blood proved to be negative. At the first examination of the patient, three pieces of tissue were excised from the lesions of the finger and three pieces from the lesions on the forearm. These were placed in Zenker's solution or ten per cent formalin. Later on, two other pieces of tissue were also excised and hardened in a similar manner. Many film preparations were made of the lesions and after they were hardened in absolute methyl alcohol, they were stained by Giemsa's solution and by Ziehl-Neelsen-Gabbett's method. The film preparations made from different parts of the lesions both suppurating, and granulating or healing areas, naturally varied somewhat in appearance. In the suppurative lesions many bacteria, particularly cocci, were found. Many of the leucocytes were also crowded with cocci.

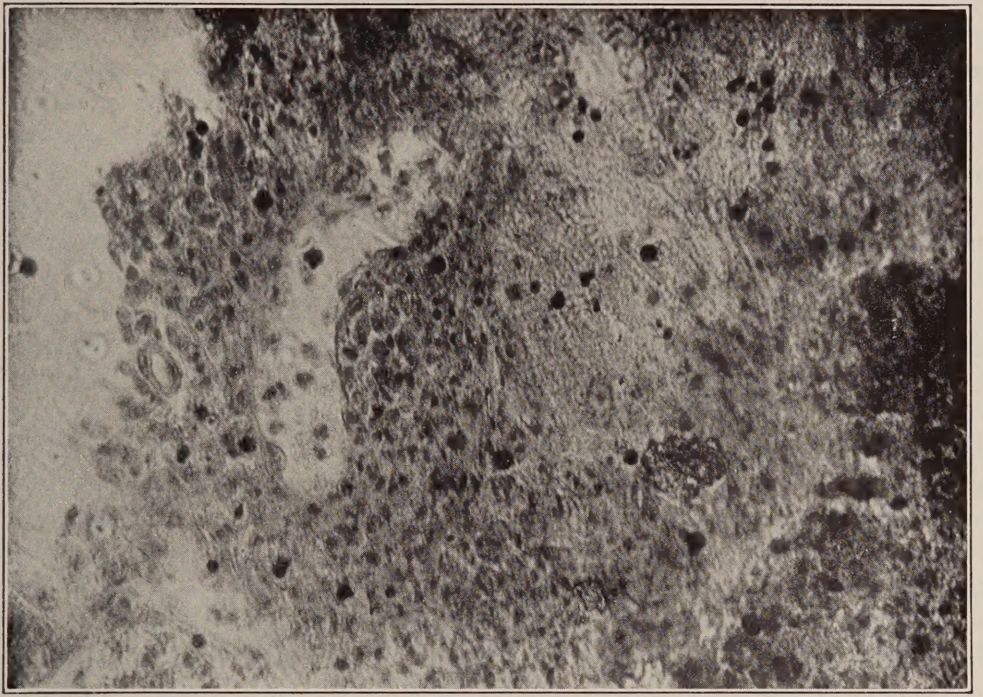
In some of the areas in the preparations made from the granulating lesions, many round disks staining deeply but without distinct double contour were observed, suggesting the spores of fungi. Some of these occurred in clumps and occasionally in the protoplasm in a degenerating cell. No acid-fast bacilli were found. A piece of granulation tissue was removed and cut up and rubbed up in saline solution in a mortar and injected subcutaneously into a monkey. Films made from the cut surface of the piece of tissue showed no micro-organisms.



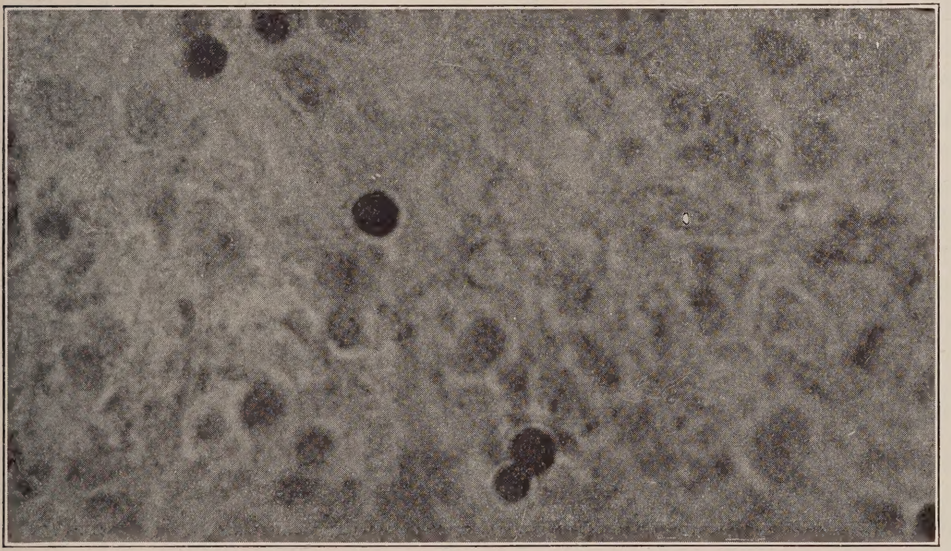
No. 257 — Sporotrichosis, Case 186



No. 258. — Photomicrograph, necrotic area in corium containing numerous blastomycetic forms of the parasite, intra-and extra-cellular. Zeiss ocular DD, compensating ocular 6



No. 259. — Photomicrograph of blastomycetic forms in the corium, in the papillae, and within a blood vessel, Case 186. Zeiss ocular DD, compensating ocular 6



No. 260. — Photomicrograph of blastomycetic forms more highly magnified, Case 186. Zeiss objective 2 mm., compensating ocular 6

Nothing definite resulted in the monkey except a local suppurating lesion which healed rather quickly and in which bacteria were found. There were no other opportunities for the inoculation of animals at the time and no conclusions obviously can be drawn from this single experiment. A number of attempts to cultivate the organism were made. In the beginning the cultures were so overgrown with bacteria and molds that no opinion of value with reference to etiology could be obtained from them. Streaking a drop of necrotic material from a suppurating lesion on six successive slants of tubed media gave only a few colonies of cocci in the fifth and sixth tubes where the colonies were isolated. Finally, however, a piece of tissue was removed from a deeper portion of a lesion, and placed in a test tube containing ninety-five per cent alcohol for a few minutes; it was then washed in sterile saline solution and sectioned with a sterile knife. Cultures were made on Sabourraud's medium from the knife and from the cut sections of the tissue, as well as from crushed bits of the tissue. These cultures after thirty-six hours showed a few isolated colonies, but cultures made on potato dextrose gave no growth. The colonies which developed in the tubes on Sabourraud's medium had at first a pinkish tinge, but they very soon became of a light brown color.

Microscopical examination of the cultures showed both hyphae and spores. The hyphae were about 2 to 3μ in width and were branching and septate. The spores were situated both terminally and along the sides of the individual hyphae, sometimes with a short sterigma visible. No chlamydospores were observed.

The histological examination of many sections of the tissues shows that an extensive inflammatory process is present in the corium. There are many small abscesses scattered through it which are nodular in form (Illust. No. 261). The center of these miliary areas consists of degenerated fibrous tissue which stains pink and uniform and contains epithelioid cells and is infiltrated with many polymorphonuclear leucocytes. There are also, toward the periphery, many endothelial phagocytes which have engulfed the polymorphonuclear leucocytes and round cells. In these necrotic areas spores of the fungi are found in good numbers. They are usually round, frequently single, and often dumb-bell shaped; more rarely in a clump of three or a chain of four elements. There is considerable variation in their size, the different forms measuring from 1 to 5μ in diameter. Many are free in the tissue, but a few are seen within endothelial leucocytes. They are also observed in the lymph spaces and within the blood vessels or in an endothelial cell in the wall of the vessel (No. 259).

These spores usually stain much deeper than the nuclei of the cells of the human tissue.

Outside the zone of more acute suppuration is one densely infiltrated with endothelial leucocytes, small round cells and a few plasma cells, with fair numbers of fibroblasts. Such zones are often surrounded in turn by areas of dense fibrous tissue. The endothelial cells of the vessels show proliferation which in places is quite extensive and some of them contain phagocytized leucocytes. In the epidermis, also, there are small abscesses containing numerous polymorphonuclear leucocytes and round cells with spores of the fungi. The papillae are also frequently infiltrated. While there is considerable newly-formed granulation tissue in the corium, polymorphonuclear leucocytes are very numerous and their presence in such large numbers, as well as their inclusion by endothelial leucocytes is a prominent feature of the inflammatory process. Very few isolated giant cells have been found. No acid-fast bacilli were observed in the sections and no spirochaetes in those stained by Levaditi's method.

Although the two culture tubes inoculated from this case were sealed at the time with the object of making a future study and identification of the micro-organism upon our return to the United States, the entire surface of the media of both tubes was covered with a thick brownish growth of micro-organisms that had evidently contaminated the tubes from the air, and no further identification of the original fungus could be made. The fungus observed in this case, however, obviously differs in some respects from the *Sporotrichum beurmanni*. The round spores are of larger size (No. 260) and also are found in considerable numbers in the deep necrotic zonal lesions. Their appearance and manner of occurrence (in several articulated cells for example) is different from *S. beurmanni* and *S. schencki*. Brumpt[1] states the spores of *Rhinocladium beurmanni* are oval and brown, varying from 3 to 5μ in length and 2 to 4μ in width. In a number of cases with infection with *S. beurmanni* and *S. schencki*, it is stated that the organism itself usually has not been observed in the tissues or film preparations made from them, but only has been obtained by cultures. In some of these reports there is some doubt as to whether the organism cultivated was not a saprophytic invader either of the wound or of the cultures from the air.

Some of the descriptions of the nine species of *Sporotrichum* isolated at various times by different observers have not always been made by those with special knowledge of the study of mycology and hence cannot always be regarded as entirely reliable. Also, the pathogenic action of some is doubtful. Usually when marked and definite lesions are produced by fungi, the organisms or the spores are present in sufficient numbers to be demonstrable by the microscopical examination as well as often by culture.

Hyslop, Neal, Kraus, and Hillman[2] have recently reported a case of meningitis due to *Sporotrichum*. As is quite clear from their illustrations of microscopical preparations of the spinal fluid, as well as of sections of the tissues, the sporotricha were present in sufficient numbers to be found without difficulty. While careful search of each smear revealed in every instance the presence of the spore-like bodies, they failed to secure any positive cultures, either by aerobic or anaerobic methods. Since the organisms were constantly present, they were unable to understand why their numerous attempts at cultures failed. Dr. Elser reported to them that in one case of skin sporotrichosis in which positive cultures could not be obtained, he considered it possible that iodine medication might have affected the organism so that it would not grow in cultures. As soon as the diagnosis was made in Hyslop's case, intensive iodide therapy was begun. In his case there were no lesions of the skin of any description. Inoculation of mice, guinea pigs, and rabbits, with spinal fluid from the patient as well as ventricular fluid and the gelatinous exudate from the brain, resulted negatively. Had the sporotricha not been demonstrated by microscopical examination of the spinal fluid and in sections of the tissues, the diagnosis of the affection could not have been made. Blair and Yarian[1] also have recently reported upon two cases of sporotrichosis of the hand, forearm, and arm, in which the *Sporotrichum* was present in sufficient numbers in the pus from the lesion for the diagnosis to be made by the microscopical examination.

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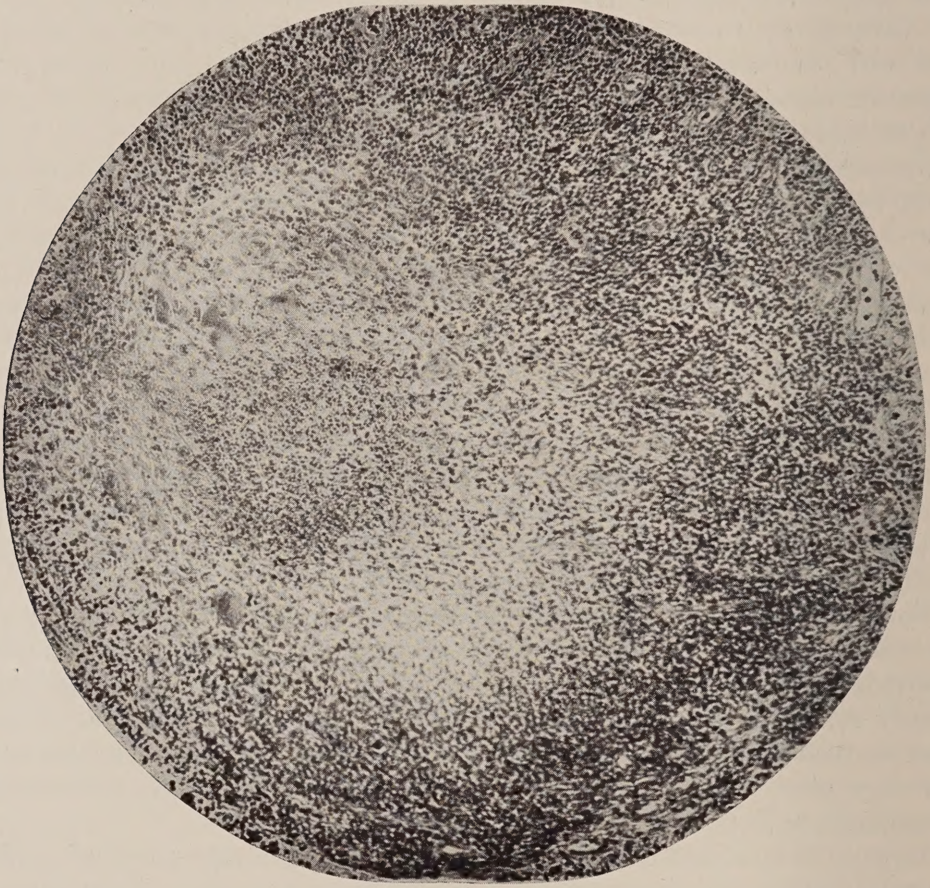
[1] Brumpt: "Précis de Parasitologie" (1927), p. 1322.

[2] Hyslop, Neal, Kraus, and Hillman: Amer. Jour. Med. Sci. (1926), CLXXII, 726.



No. 261. — Photomicrograph of necrotic area in corium, Case 186.
Zeiss objective AA, ocular 6

In cases in which it has not been possible to find from the microscopical examinations recognizable forms of sporotricha, it seems possible that young spores of the micro-organism may be present in the tissues. In this connection De Souza Campos and Paulo de Almeida[2] have recently studied twelve cases of blastomycosis observed in Sao Paulo. In every case there were numerous parasites in the tissue which resembled tuberculous granulation tissue. The micro-organisms found were spherical and showed all sizes from exceedingly minute bodies, coccus-like, to 25 to 30μ; these minute bodies surrounded the larger cells which were unstained; they were sometimes gram-positive or gram-negative. They regard the minute forms as probably spores by means of which these fungi multiply in the tissues. Drawings and photomicrographs show a central parasite surrounded by small spherical spores or granules.

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[1] Blair and Yarian: Jour. A. M. A. (1928), XCI, 96.

[2] De Souza Campos and Paulo de Almeida: Ann. de Faculdade de Medicina de Sao Paulo (1927), II, 203.

Regarding the differentiation of the different species of sporotricha isolated from human beings, Weidman [1] says that during the last eight years he has been able to collect seven strains of fungi causing blastomycosis.

Filho [2] has recently isolated in Brazil, from a case with hard vegetating lesions covered with crusts, and associated with two small abscesses, a fungus which produced yellowish-white colonies on Sabourraud's medium. He believes it is still another species, and has named it *Sporotrichum fonsecai.*

In not all of the cases which resemble sporotrichosis clinically have fungi of the genus *Sporotrichum* (*Rhinocladium*) been isolated.

Froilano de Mello and A. Rodrigues [3] have reported, with illustrations, a case of fungus infection in which the verrucose or pustulo-ulcerative lesions resembled those of our Liberian case. They, however, believe that the organism they found was a *Blastomyces* allied to the "type Gilchrist," but they remark that there was a total absence of giant cells and mononuclear infiltration in the tissue. DaFonseca, Area Leao, and Penido [4] have isolated from cases with lesions resembling sporotrichosis a species of *Hormodendrum* in one instance, and in another a fungus identified as *Hemispora stellata.* Montpellier and Catanei [5] have also isolated from cases with similar lesions in one instance a *Blastomyces* called *Cryptococcus montpellieri*, and in another a species of *Hormodendrum*, *H. algeriensis* (see page 346).

Finally, Da Matta [6] has recently reported a case of ulceration with surrounding nodules from which a fungus which he named *Sterigmatocystis tropicalis* was isolated.

Many of the ulcerative lesions we observed in Africa contained spores of fungi. We not infrequently found such spores in the microscopical examinations of such lesions and also obtained them sometimes in cultures. In many instances it was impossible to say whether the fungi were present as saprophytic invaders or whether they constituted a secondary infection of the lesion which they actively modified.

Boucher [7] in his extensive study of mycosis in the Ivory Coast points out the frequency of mycotic infection and found that in Bouake a third of his patients were afflicted with mycosis. Mycosis, syphilis, and phagedenic ulcer were the three chief diseases. He describes sixteen cases of mycosis diagnosed by examinations, in which *Scopulariopsis* was found, one of pseudomycosis in which an encapsulated bacillus was encountered, one of pseudomycosis with a micrococcus, two of mycosis in which *Acremonium* was encountered, one with *Cephalosporium*, and three with *Hyalopus*.

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[1] Weidman: Arch. Derm. and Syph. (1929), XIX, 875.

[2] Filho: Rev. Medico-Cirur. do Brasil (1929), XXXVII, 266.

[3] De Mello and Rodrigues: Bull. Soc. Path. Exot. (1929), XXII, 142.

[4] DaFonseca, Area Leao, and Penido: Comptes Rendus Soc. Biol. (1927), XCVII, 1772.

[5] Montpellier and Catanei: Bull. Soc. Path. Exot. (1926), XIX, 586; Ann. Derm. et Syph. (1927), VIII, 626.

[6] Da Matta: Bol. Inst. Brasileiro de Sci. (1928), III, 51.

[7] Boucher: Bull. Soc. Path. Exot. (1918), XI, 306.

A further study of the mycotic infections in parts of Africa by one carefully trained in both mycology and bacteriology is needed. Obviously most rigid precautions must continually be taken with reference to cultures in the humid, hot regions. Our sterile tubes of Sabourraud's medium, potato dextrose, etc., though carefully sealed, would very frequently develop, as the months passed by, colonies of fungi, even before the tubes were opened. In some unexplainable way, a few very minute spores evidently found their entrance to these tubes. It seemed very probable that the infection was not originally present in the tubes and media at the time they were sealed, since the media in many of the tubes became contaminated only after they had been in Africa for some six to nine months. Obviously, one cannot conclude from the development of fungi in cultures made from surface lesions of patients that the fungi have necessarily an etiological relationship or pathogenesis. The histological examination of the diseased tissues frequently gives additional valuable information of this nature.

It is also exceedingly difficult to recognize the spores of some fungi in necrotic lesions, for at times, unless they have a double contour (and many have not), it is impossible to distinguish them in their morphology, from rounded chromatinic particles or granules extruded from endothelial cells or leucocytes.

The danger of postmortem invasion of organs and tissues both before and after the performance of the necropsy must also be borne in mind. We have encountered in Africa such postmortem invasion of the intestine and spleen with fungi (see page 223). The possibility of tissues becoming infected with fungi through the water which is used for washing the ones hardened in Zenker's solution, should also be considered. There is no running water, except that in brooks or streams in the regions of Africa in which we carried on all of our field work. The quality of the water obtained particularly in parts of East and Central Africa is none too good for any purpose for which man may wish to use it.

At the recent meeting of the Royal Society of Medicine [1] the urgent need for a satisfactory botanical classification of pathogenic fungi which would permit of rapid and certain identification of these fungi was emphasized. It was further pointed out that in many cases the pathogenicity of the fungi obtained is not at all certain. Weidmann [2] has recently pointed out the importance of employing the monospore technique in the study and differentiation of the dermatophytes.

Hormodendrum infection. An unusual case of swelling and deformity of the left foot of a negro was observed in the Belgian Congo at Lukutu (Case 500). The man looked to be about forty years of age, and his general condition appeared to be good. He walked about with the assistance of a staff. The left foot was

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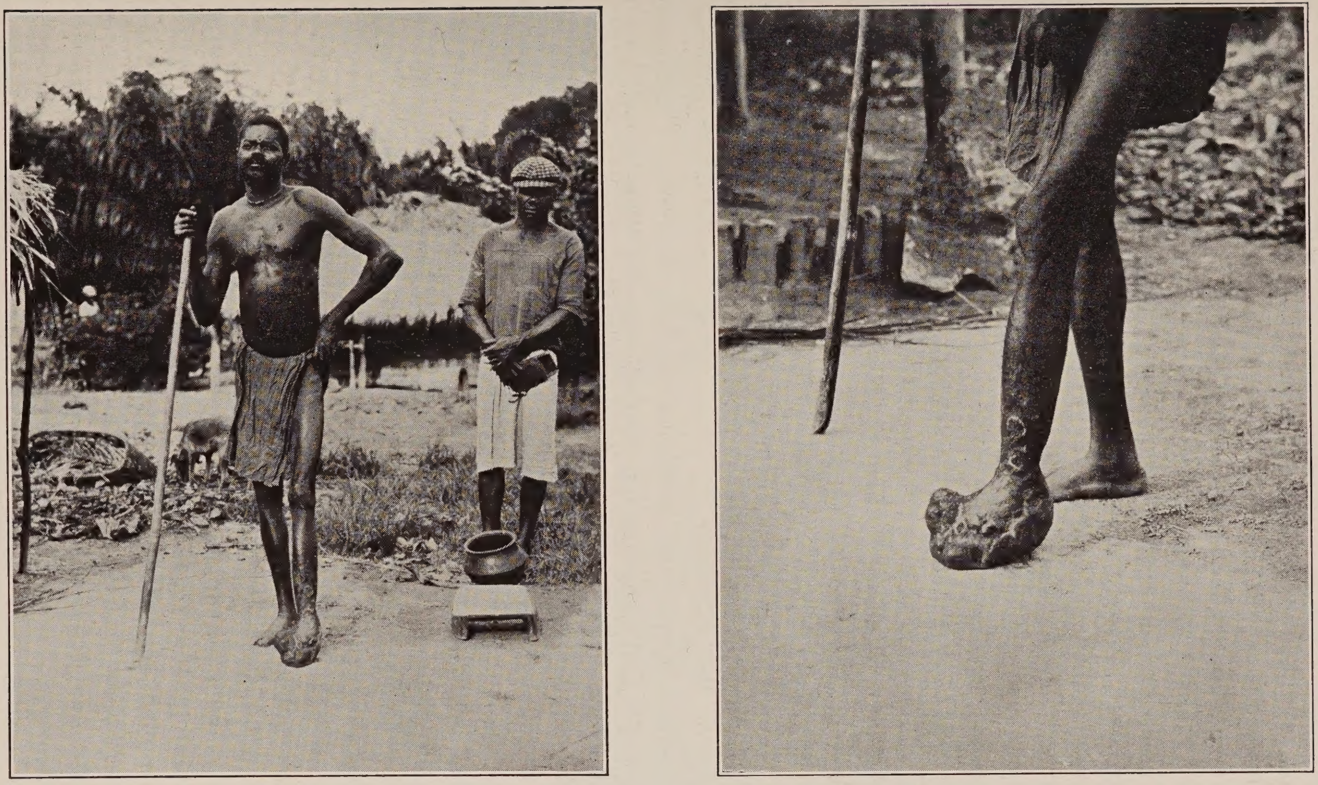
[1] Trop. Dis. Bull. (1928), XXV, 739.

[2] Weidmann: Arch. Derm. and Syph. (1929), XIX, 867.



Nos. 262, 263. — Case 500, hormodendron infection, "potato foot" swollen and deformed in such a way as roughly to resemble an irregularly-shaped potato (Nos. 262–263). The great toe was represented by a knob projecting upward. There was practically no evidence of the existence of other toes, they having disappeared in the swollen mass. The stump of the foot consisted of rather hard tissue, the skin firmly adherent to the surface, generally smooth except for the presence of two superficial excoriations, about 3 to 4 centimeters in diameter. These were apparently covered with sawdust. Some soft black substance had also been applied over nearly the whole surface of the skin of the foot. There were several superficial scars on the mass which were pink in color. In the photograph two superficial scars may be seen just above the left ankle. In these there was moderate deficiency of pigment. The legs appeared constricted at the ankle, owing particularly to the swelling of the foot.

Nothing definite regarding the history of the pathological condition could be obtained except that it had existed for a long time. It obviously is of a chronic nature. Examination of other parts of the body showed that the right tibia bulged somewhat anteriorly. The metacarpals of the right hand also seemed slightly curved and bent, and the motility of the hand somewhat diminished.

Besides the scars already referred to on the left foot and ankle, there were irregularly-shaped superficial scars on the inner aspects of the thighs, left lower leg, forearms, anterior surface of the right elbow, the back of the hands, and on the cheeks.

The pathological condition resembles madura foot only to some extent in its size and shape. In mycetoma the toes are usually more or less preserved and generally but little affected. In the present instance, moreover, no nodular lesions were present and no openings or sinuses were apparent, as are usually noted in mycetoma. In microscopical examination, no mycetoma granules were found, and no acid-fast micro-organisms.

To judge from the photographs published, a condition which to some extent resembles the one described here is that reported as occurring in Netherlands-India by Ten Brink[1] as sporotrichial in character. Apparently, however, from his description ulcerations were present, though these cannot be distinguished in the photograph in his article. The nature of the infecting micro-organism and the histological conditions are not described.

Five pieces of tissue were removed from the lesion of our case for histological examination, the tissues being placed in Zenker's solution at the time of removal. Some of these pieces of tissue were hard and fibrous-like in consistency, while others were much softer. Eight film preparations were made with material obtained from the cut section of the moist tissues from the different portions of the lesion; these were later stained in Giemsa's solution and by carbolfuchsin and Ziehl-Neelsen-Gabbett's method. On microscopical examination very numerous round and oval mycotic forms both free and enclosed in epithelial cells were found. Occasionally they were seen within endothelial leucocytes. Other slides showed enormous numbers of small cocci and smaller numbers of bacilli, the latter however were plentiful. Large coccoid forms occurring singly, more fre-

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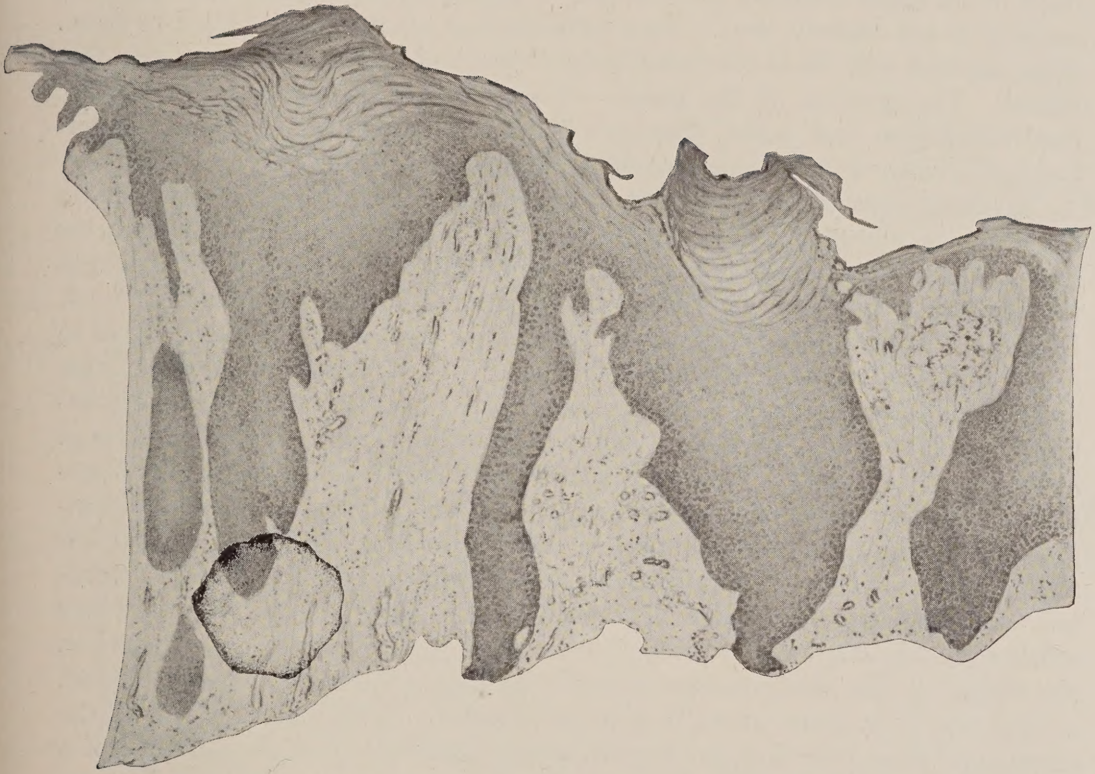
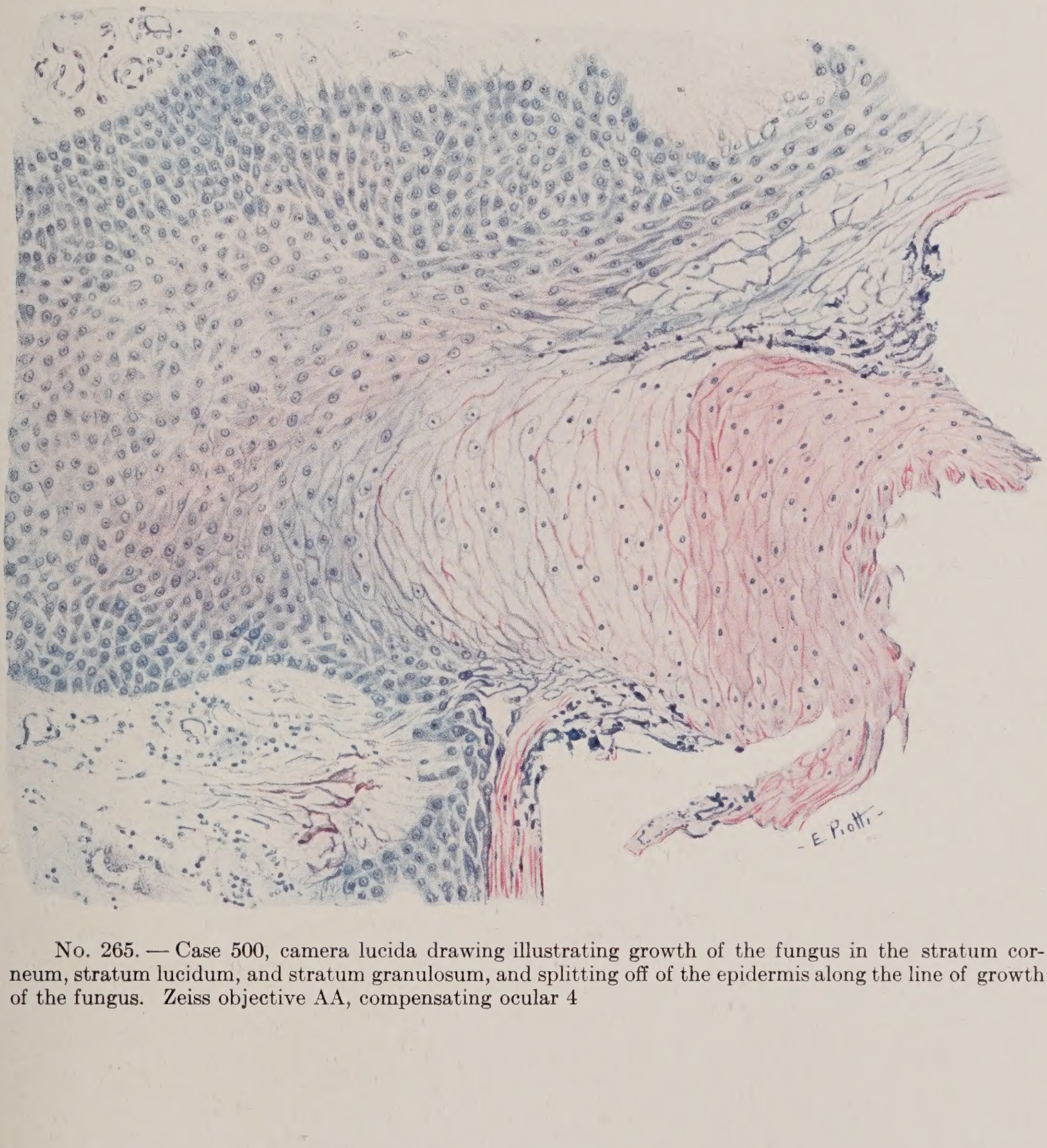
[1] Ten Brink: Gen. Tijdschr. Nederl. Indie, Deel 56, Nr. 2, S. 178.



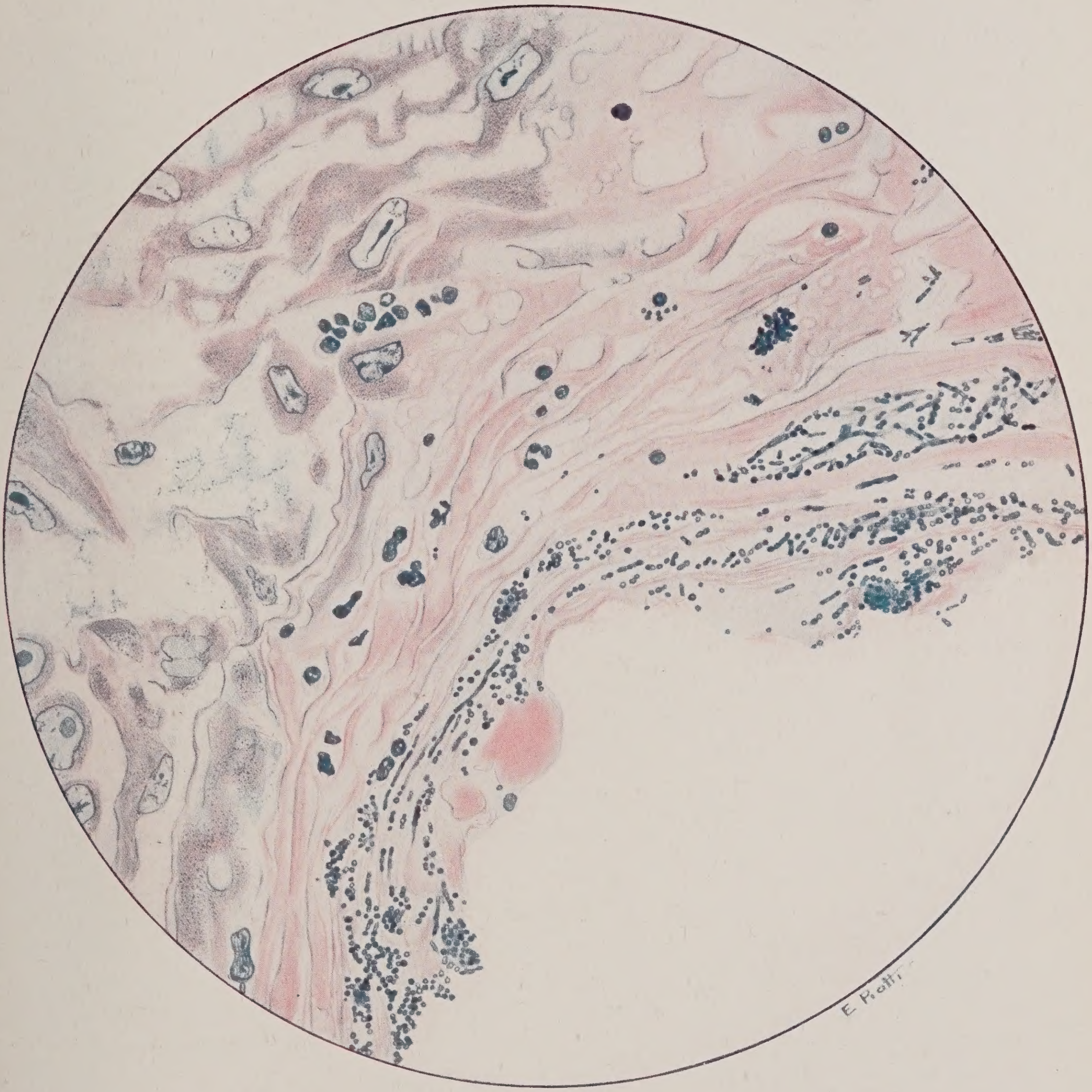
No. 264. — Case 500, drawing illustrating thickening of stratum corneum in places, elongation of papillae, and atrophy of stratum mucosum in others, and downgrowths of epithelium. Zeiss objective A^2, compensating ocular 4

quently in pairs, and occasionally in clusters of five, were also present. These organisms are found both free and within cells. They are particularly abundant in the smears that contain numbers of red blood corpuscles and many leucocytes. Epithelial cells may contain anywhere from several to many partially agglomerated forms. The organisms vary in size even in the same group, some having a much larger diameter than others. Whether they are spores of a fungus or bacteria is not entirely clear. No double contour can be distinguished in them. Films stained with Ziehl-Neelsen-Gabbett's method do not reveal any acid-fast bacilli. The sections of the tissues were stained in haematoxylin and eosin, methylene blue and eosin, Giemsa's solution, Gram's stain, Ziehl-Neelsen-Gabbett's method, and Levaditi's silver impregnation stain.

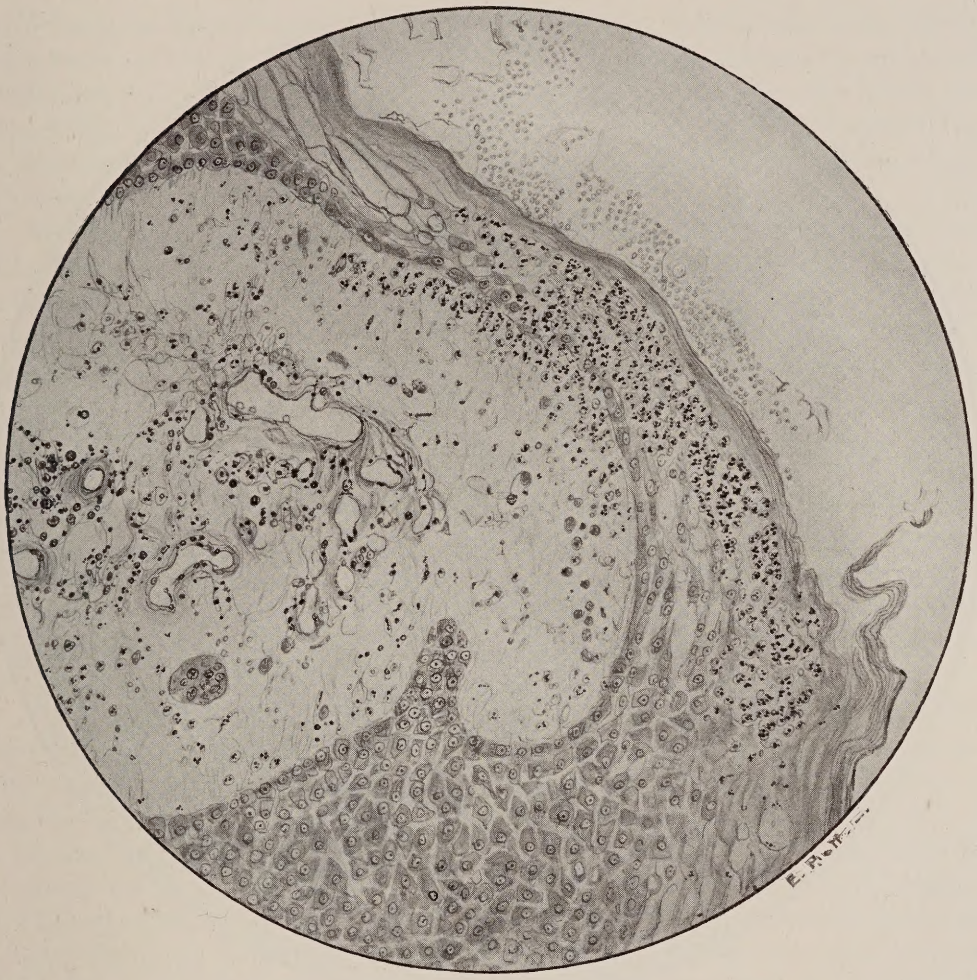
Histological study shows that in most of the sections the surface epithelium of the skin is unbroken. However, the epidermis varies considerably in character and in thickness. In the sections made from one block of the tissue, in some areas the stratum corneum is greatly thickened, and in others very much thinned. Likewise, the stratum mucosum in some places is also greatly thickened, and in others atrophied or very little of it remains. No. 264 illustrates very well this condition. In one portion of the section there are downgrowths of the epithelium into the corium, sometimes simulating an appearance that may be seen in epidermal carcinoma. However, such hyperplasia is not present in the sections from other parts of the tissue removed. The papillae in places are elongated, and the stratum mucosum so thin that a few papillae reach on the surface almost to the stratum granulosum or stratum lucidum. In examining the epidermis (with objective AA, ocular 6), especially in sections stained with Giemsa's solution, deeply-staining blue, wavy, and sometimes irregular lines are visible on the surface of the pinkly-stained stratum corneum where it is greatly thinned, or invading it in areas where it is hypertrophied. With higher powers of the microscope these blue lines are seen to consist particularly of the elements of a fungus. This fungus, by invading the stratum corneum in its deeper portions, evidently gradually causes its cells to exfoliate and to be split off sometimes at a depth as low as its base in the stratum granulosum. In No. 265, near the lower edge of the illustration, the line of cleavage of the epithelium that has already occurred by the growth of the fungus, may be distinguished, and in the upper portion of the picture may be seen the blue line of invasion of the fungus growing in and extending almost to the surface of the stratum mucosum. With objective $\frac{1}{12}$ (2 mm. N.A. 140), the cylindrical, elongated, and undulating mycelial threads may be distinguished as well as the rounded spores, sometimes budding, or lying in clusters or partially agglomerated groups. In No. 266 large numbers of such forms of the parasite are seen in the stratum corneum, some of which have already entered the cells of the stratum mucosum. In these areas a few endothelial phagocytes are also present. In No. 267, a drawing made with objective AA, ocular 10x, the stratum mucosum is richly infiltrated with polymorphonuclear and endothelial leucocytes, and the papillary layer also shows infiltration, though with smaller numbers of these cells. Proliferating fibroblasts are also visible. In the endothelial cells about the sweat glands and



No. 265. — Case 500, camera lucida drawing illustrating growth of the fungus in the stratum corneum, stratum lucidum, and stratum granulosum, and splitting off of the epidermis along the line of growth of the fungus. Zeiss objective AA, compensating ocular 4

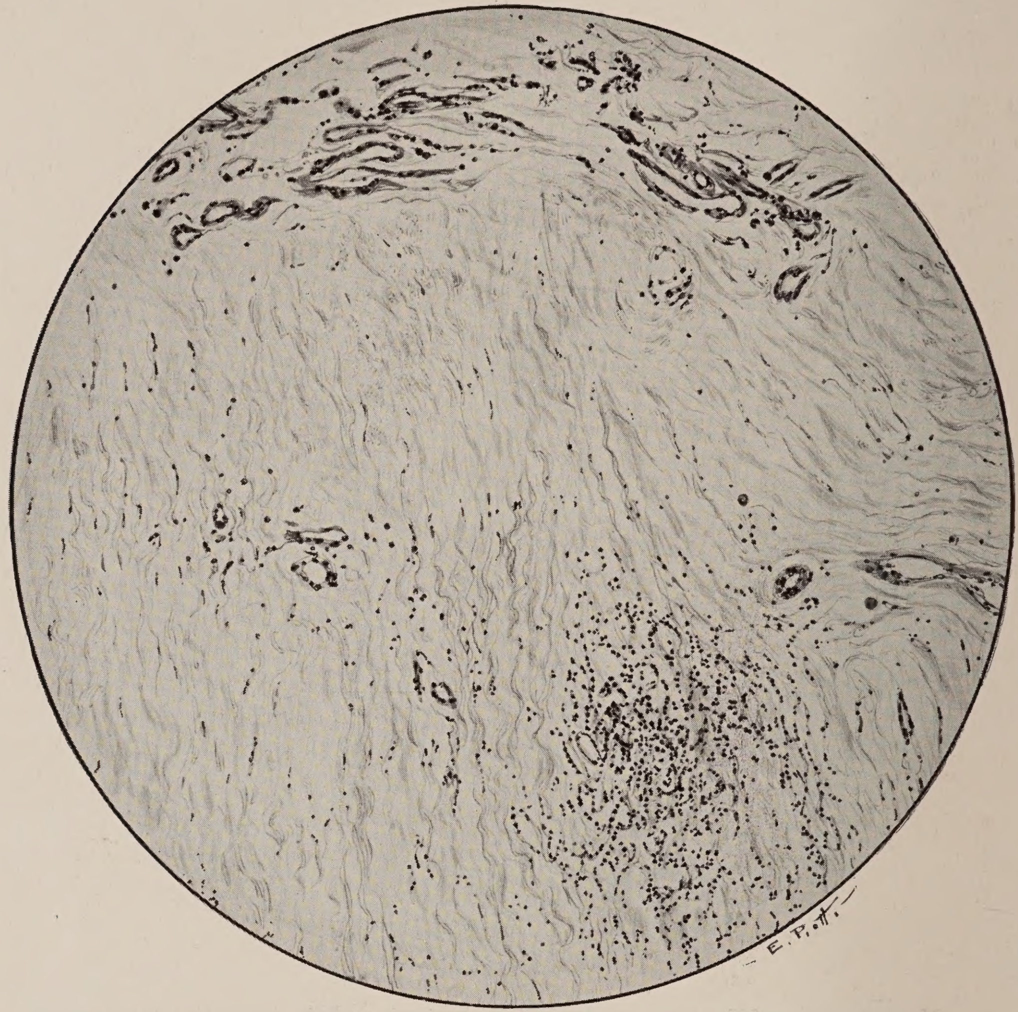


No. 266. — Case 500, camera lucida drawing illustrating fungus in stratum lucidum and stratum granulosum. Zeiss objective 2 mm., compensating ocular 6



No. 267. — Case 500, camera lucida drawing illustrating cellular infiltration in the papilla and extending into the stratum granulosum and stratum lucidum. Zeiss objective AA, compensating ocular 10x

blood vessels in the papillary layer occasionally round or budding spores of the fungi may be distinguished. In a very few areas small abscesses are found in the superficial portions of the stratum mucosum, over which the stratum corneum is greatly thinned and in which the nuclei still persist in the corneal cells. Finally, in some places the stratum corneum and stratum mucosum have been entirely destroyed for a short distance and the corium thus exposed. In such areas coagulation necrosis of the tissue has taken place and spirochaetes and fusiform bacilli have secondarily invaded the upper layers. Such a condition, however, is observed in only two places of the sections from one block of the tissue removed. In the other blocks of tissue the epithelium is more or less preserved. In all of the sections the corium is generally oedematous. There are many elastic fibers present, and newly-formed blood vessels are numerous. In the corium also one finds many miliary areas of infiltration with leucocytes and round cells. Prolif-



No. 268. — Case 500, camera lucida drawing illustrating inflammatory reaction in the corium, particularly about blood vessels and sweat glands. Zeiss objective AA, compensating ocular 6

erating fibroblasts are also seen in the surrounding tissue. The infiltration occurs particularly about the sweat glands and blood vessels (No. 268). In other areas in the corium there are small haemorrhages about which a few round or budding spores of the fungus are visible. In still other small areas deep in the corium necrosis of the tissue has occurred, and in the vicinity there is marked infiltration with leucocytes, and occasional spores of the fungus may also be distinguished.

At the time of removal of the tissues for histological examination, a tube of Sabourraud's medium and one of agar were inoculated with serous fluid expressed from the cut surface of the lesion. These were the only culture tubes at hand on the one occasion that we had opportunity to observe the patient. An examination of these tubes 36 hours later, after we had returned to the improvised laboratory on our boat, showed the surface of the agar tube entirely overgrown with bacteria. However, in the tube of Sabourraud's medium, where the colonies were more or less isolated though not entirely so, mycelial elements and spores were numerous although mixed with bacteria. The colonies on this media were of different color, some dark reddish-brown, others with a brownish-green tinge. A diphtheroid bacillus was present in the former, while in the latter colonies mycelial elements were numerous.

Microscopical examination of moist preparations from these showed a mycelium consisting of elongated, undulating, septate threads, measuring 3 to 4μ in diameter. The hyphae were dendritic, sometimes anastomosing. The conidiophores often showed binary branching. Each branch, however, might consist of only a single cell, or in other instances of two or three articulated cells. These cells were not swollen at the extremity but were cylindrical or ovoid. At the end of the conidiophore were 1 to 3 small protrusions about 1μ in height, resembling short sterigmata. By means of these protrusions the conidiophore was joined to the conidia. The latter were round or oval, and from 2.5 to 6μ in their greatest diameter. They apparently constituted blastospores and were capable of budding. Many single cells, 8 to 12μ in length and 3 to 4μ in width, resembling conidiophores which had been disassociated, were present, as well as rounded clusters of blastospores. Large numbers of single, rounded, or budding blastospores were also present, indicating their caducous character.

From these characteristics the fungus apparently belongs in the genus *Hormodendrum* Bonord, 1851. It was not possible to isolate it in pure culture, and it was rapidly overgrown by the bacteria and could not be again recovered. It was also not practicable to make any animal inoculations with the culture.

Castellani [1] and DaFonseca, Area Leao and Nogueira Penido [2] have recently reviewed the literature regarding the genus *Hormodendrum* and its relationship to *Cladosporium*. DaFonseca and his associates have also made the most complete study of the genus that has been carried out, and they have isolated a new species *Hormodendrum langeroni* from an ulcero-nodular form of mycosis observed in Brazil. In this patient the lesions were situated on the right forearm and arm, arranged along a line running from the posterior surface of the hand to the middle of the anterior surface of the arm. The ulcers were covered by granulation tissue and yellowish scabs. The culture of the fungus obtained showed colonies, at first greenish and later becoming darker and almost black. The mycelium was formed of elongated septate branched hyphae. The conidiophores were erect and branched or unbranched, and the branches were formed of single cells or of several articulated cells. The vegetative hyphae were 2 to 4.5μ in diameter; intermediate cells 7 to 12 by 3 to 4μ; the conidia 2.5 to 6 by 2.5 to 14μ.

Hormodendrum langeroni is morphologically related to *Hormodendrum fontoynonti*, Langeron, 1913. The latter species was found by Fontoynont and Carougeau in a dermatitis called *hodi potsy* in Madagascar. Still another species,

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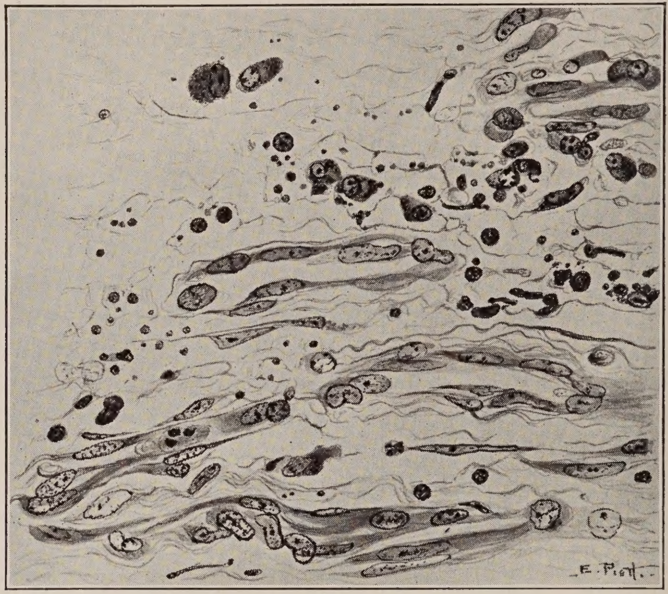
[1] Castellani: "Fungi and Fungous Diseases," reprinted from Arch. Derm. and Syph. (1927), pp. 388, 571, 714; (1928), pp. 61, 194, 350.

[2] DaFonseca, Area Leao, Nogueira Penido: reprinted from Sciencia Medica (1927), V.

Hormodendrum pedrosoi Brumpt 1921[1] has been discovered and cultivated by Pedroso from a nodular and verrucous dermatitis in Brazil.

Montpellier and Catanei[2] have also recently reported a case of about ten years' duration in which the lesions consisted of polymorphic eruptions involving the right leg and instep. From them a fungus was obtained on Sabourraud's glucose medium which was identified as a new species of *Hormodendrum* to which the name of *H. algeriensis* has been given. Histologically the fungus was present in the form of spherical or ovoid cells 2 to 10μ in length, rarely arranged in chains.



No. 269. — Case 500, camera lucida drawing illustrating cellular reaction and spores of fungi in the corium. Zeiss objective DD, compensating ocular 6

The subcutaneous inoculation of a rabbit with the culture of this organism led to the formation of a large abscess, in the base of which the fungus was present and from which it could be recultivated.

The organism from our African case is probably identical or closely related to *Hormodendrum langeroni* Fonseca.

Trichophyton and *Tinea vesicolor* infections of the skin were found to be common in Liberia. These Liberian cases showed no peculiarities and were similar in appearance to cases of these affections observed in other parts of the tropical world. Cases known as *craw-craw* were also frequently observed in the interior of Liberia, especially among children. We have already referred to the discussion regarding the significance of filariae in such lesions and the observations of O'Neil and of Macfie who described microfilaria in some of the papules. The Africans undoubtedly at times employ the term *craw-craw* for different affections of the skin in which itching and scratching occur. In a number of the

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[1] Brumpt: Précis de Parasitologie," 1927, 4th ed., p. 1333.

[2] Montpellier and Catanei: Ann. Derm. et Syph. (1927), VIII, 626.

Liberian cases, *Sarcoptes scabiei* was found by Theiler upon microscopical examination of scrapings from the skin, but no other organisms were observed in connection with the condition. Dr. Shattuck made the clinical observation that in Liberia the distribution of the lesions of scabies differed from that of Europe and the United States. The lesions in Liberia are commonly seen upon the lower limbs, whereas in Europe and the United States they characteristically stop at the knee. He also made the same observation in Amazonia.

Craw-craw in another form was also observed in Liberia with papular and in some instances older vesicular lesions. In Case 184 (No. 270) of this nature the distribution of the lesions was particularly over the elbows, a few over the posterior surface of the arms, and over the abdomen and very profuse over the buttocks. The lesions generally consisted of dried-up vesicles or papules from 2 to 3 mm. in diameter and numerous smaller pustules. When these were scraped with a knife, very shallow ulcers were revealed. Many microscopical preparations were made from the base of the papules and pustules and from the scrapings of the shallow ulcers. Pieces of the skin containing the papules were hardened in alcohol and Zenker's solution. Examination of the film preparations from the lesions showed large numbers of cocci and polymorphonuclear leucocytes, the micro-organisms being both intra- and extra-cellular. No spirochaetes nor *Blastomyces* were observed and no organisms were seen within the epithelial cells. Sections of the tissues examined after our return show miliary abscesses occurring in the epidermis (No. 271) lying beneath the stratum granulosum and the mucous layer. The papillae are pushed downward by the exudate and their upper surfaces are infiltrated and necrotic. The stratum corneum is preserved over the abscesses, as may be seen from the illustration. The abscess cavity consists of an albuminous exudate, staining lightly pink, occupying the area just below the stratum granulosum. Almost no cells whatever are present in it. Below this area there is one very richly infiltrated with polymorphonuclear leucocytes, endothelial cells and a few fibroblasts. Cocci, both free and within polymorphonuclear leucocytes, are present in large numbers in this area. Sometimes these micro-organisms are in chains of four or five. They do not extend very deeply into the papillae. At the sides of the abscesses *cocci* may be seen within the lymph spaces and small blood vessels or papillae. About these vessels there is sometimes slight endothelial proliferation, and in their vicinity a dense infiltration with endothelial cells and polymorphonuclear leucocytes, the former predominating in the deeper layers of infiltration. The deeper portions of the corium are particularly free from infiltration. This form of *craw-craw* is certainly of bacterial origin and the micro-organism shown in the photomicrograph is obviously the etiological factor in the lesions (No. 272).

Rodhain[1] has recently reported upon cases of papular dermatitis, epidemic in the Belgian Congo in which the lesions started first as small circumscribed papules which within twelve days grew to a diameter of 12 to 14 mm. and were then raised 2 to 3 mm. above the surrounding skin. A deep vesicle then appeared which later broke down and left an ulcer roughly 1 cm. in diameter. This ulcer

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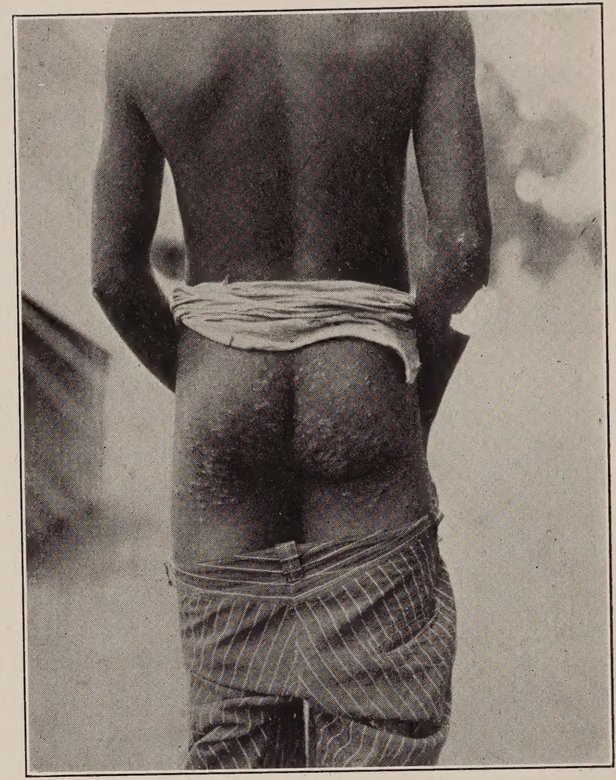
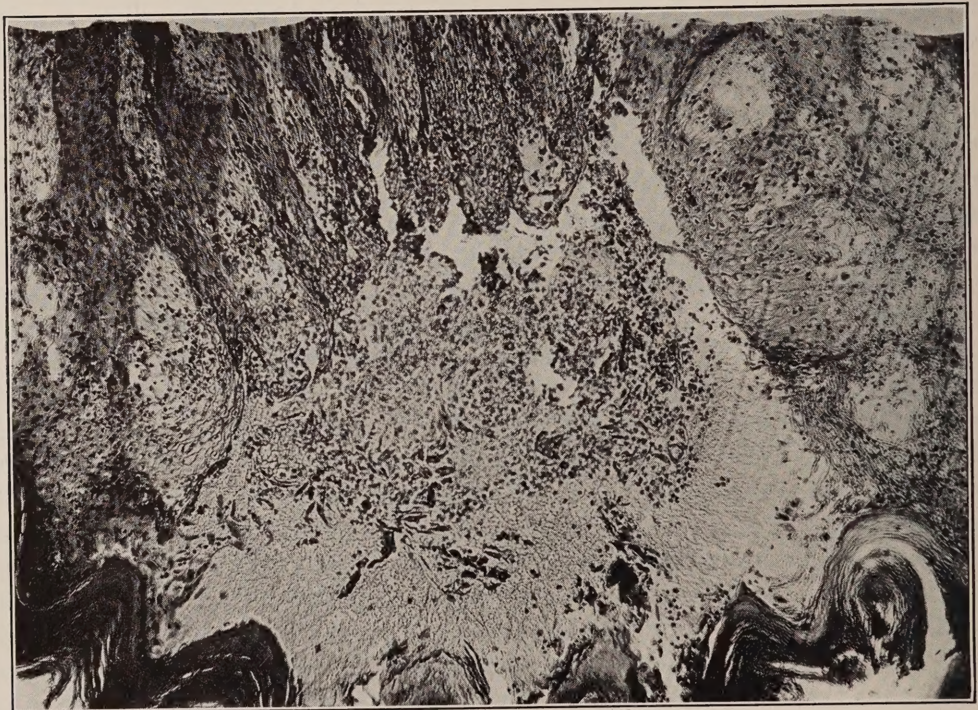
[1] Rodhain: Ann. Soc. Belge de Méd. Trop. (1928), VIII, 325.

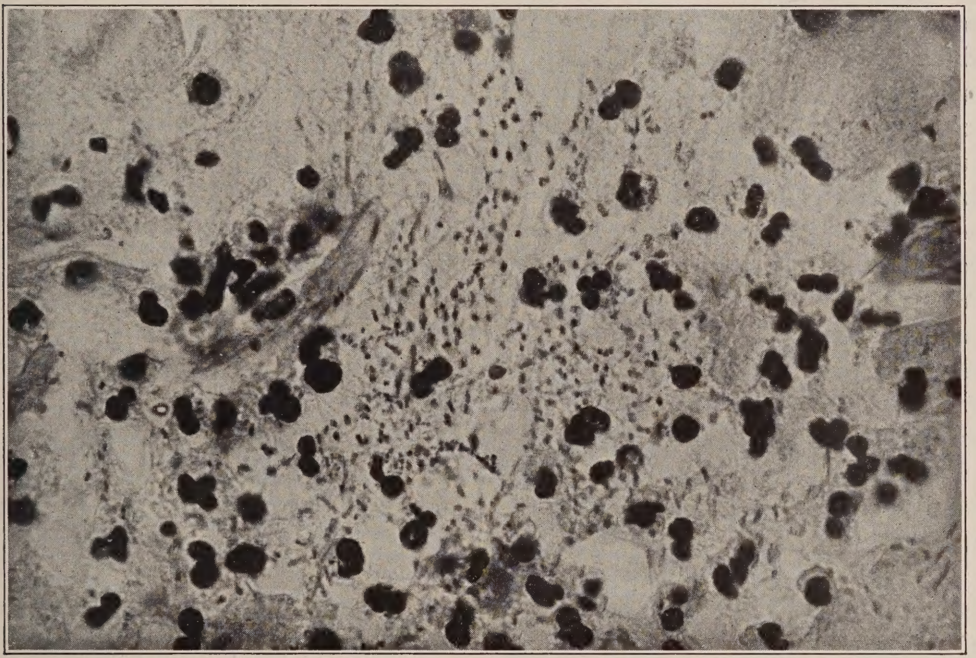


No. 270. — Craw-craw, Case 184



No. 271. — Photomicrograph, miliary abscess in epidermis, Case 184. Zeiss objective AA, ocular 6

sometimes became scabbed over. Under local antiseptic treatment the lesions healed within three weeks. The histology showed proliferation, oedema of the mucous layer, with infiltration, and mononuclear infiltration of the dermis. Vesiculation soon appeared deep in the mucous layer and local cellular necrosis occurred rapidly. At this stage the papillae were very congested, the greater number of the invading cells being polymorphonuclears with few groups of eosinophils, irregularly distributed. Usually the infiltration descended only as far as the papillary layer, never reaching the subcutaneous tissues. The condition suggested a microbic origin, but attempts at culture and animal inoculations appeared inconclusive, although the latter were possibly suggestive of a streptococcal infection.



No. 272. — Photomicrograph of edge of abscess showing character of inflammatory exudate and numerous cocci, many in chains, Case 184, Zeiss obj. 2mm., oc. 6

Vitiligo or *leucoderma* was also found to be common in Liberia. It is not only more frequent in the dark-skinned races generally than in the Caucasian race, but is particularly frequent in the negro. Apart from the idiopathic form apparently due to heredity and consanguinity of parentage, other forms with depigmented areas, relative or complete, also were found to be common. These were especially observed in skin lesions of leprosy or of syphilis and in the scars of treponemiasis. Dr. Shattuck also has observed that ringworm or even the mild tinea vesicolor infections may cause a diminution of pigment in the affected areas.

Gupta[1] points out that leucoderma in some of the natives of India may appear after local irritation, for example from any dermatitis or the wearing of a tight belt. The commonest form seen by us, however, was of the type described as idiopathic vitiligo, an instance of which is illustrated in Nos. 275–276 (Case 389). In this case there were widespread pinkish-white patches on the hands, and, to a less degree, on the feet. The palms and the heels were also markedly affected but the largest lesion extended along the inner side of the right arm from the palm nearly to the elbow. There were small depigmented patches along the edges of the larger white areas and scattered over the body. A patch on the lip included part of the mucous membrane of the lip and of the gum. The skin of the back appeared normal in every respect save in color. On the depigmented areas on the forearm, the skin was of normal texture but exhibited irregular areas which were faintly reddish in color. On the hands the skin seemed to be thickened and of abnormal texture. In some areas there was slight scaling. On the palms and in the folds and about the joints there was more scaling and exfoliation of the horny layer, and pitting of the surface of the skin. Scrapings from the skin examined in potassium hydroxide solution showed no mycelia or spores of fungi. In stained preparations of scrapings made from the skin, the same result was obtained. Histological study of sections of skin from this case also show that the process is one of true vitiligo and that no fungi are present. In fact, the sections show no pathological changes with the exception of the absence of pigment. There is not only loss of pigment in all the chromophores but also the whole area of skin in the affected patch takes a much paler stain in comparison with the normal skin seen at the edge of the tissue. Very few pigment-containing wandering cells are present in the corium. There is nothing from the microscopical or histological study to suggest that the affection is parasitic or infectious in origin.

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[1] Gupta: Far Eastern Asso. Trop. Med., Brit. India (1927), I, 129.

Albinism (No. 277) was also observed in individuals with dirty, white, transparent skin and yellow or yellowish white or reddish-white hair. These patients usually appeared to be in poor physical condition, apathetic and afflicted with photophobia and nystagmus. Such cases of *albinismus universalis* are usually regarded as congenital.

Seborrhoea. Patches of seborrhoea were also observed, particularly on the backs and shoulders of natives in Liberia. Scrapings from these lesions usually showed a few yeast cells, sometimes free and sometimes enclosed within epithelial cells. It is so frequent, however, to find yeast cells in the superficial scrapings of the skin of Africans, that in many instances it was not clear to us that they had any significance of importance. In some cases in which we found yeast cells in scrapings from the skin, the histological study of the tissues made later did not show the presence of these micro-organisms (Cases 192 and 410, Nos. 278–279). Obviously their invasion of the epidermis was very superficial.

Acton and Panja[1] have recently made an extensive study of seborrhoea dermatitis or pityriasis in India. They point out that the large yeast-like organisms that bud, and the spores of malassez, or the flask bacillus of Unna, and the gray coccus or morococcus which have been described by Sabourraud in sebor-

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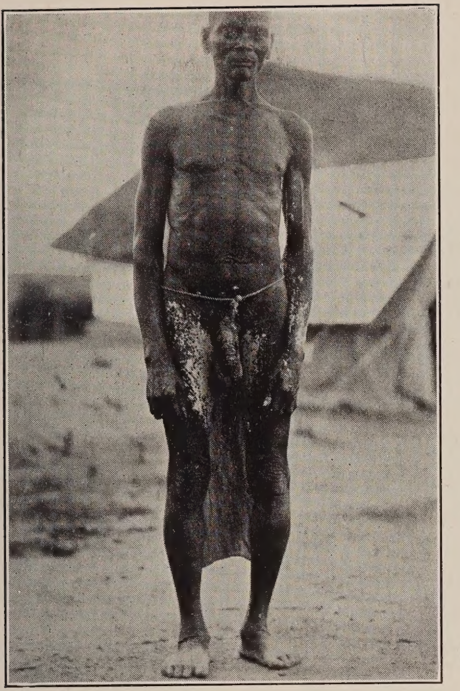
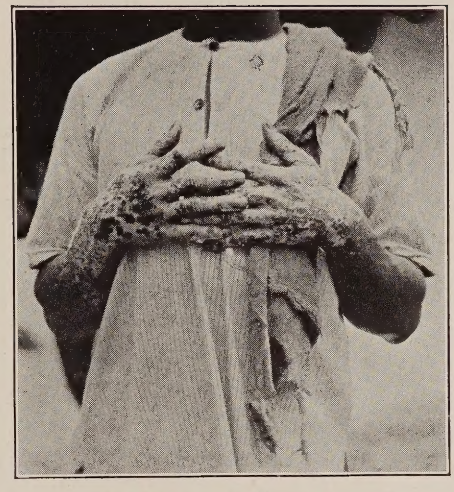
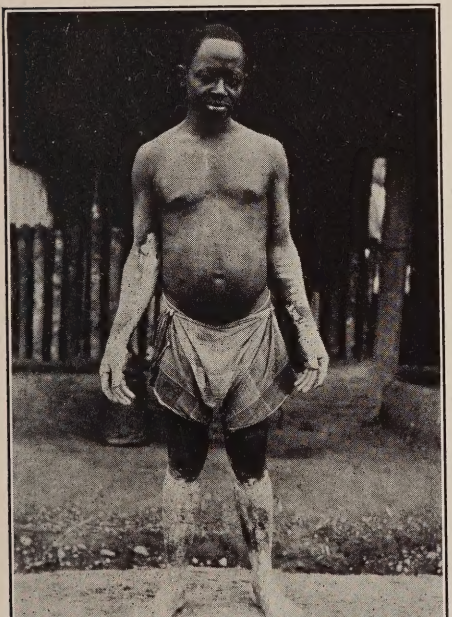
[1] Acton and Panja: Indian Med. Gaz. (1927), LXII, 603.

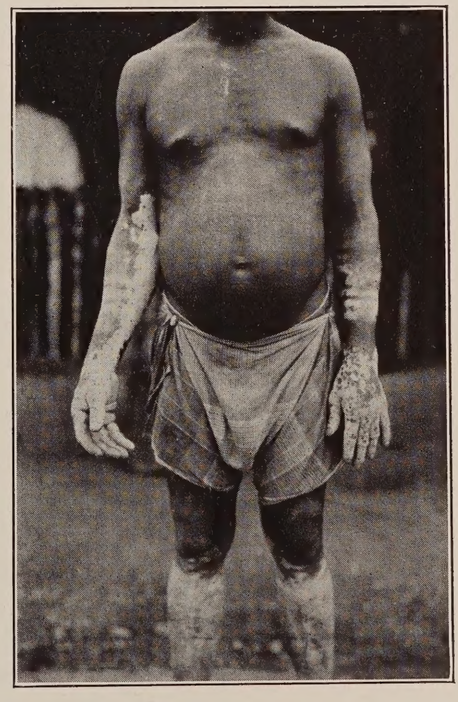


No. 273. — Case 100



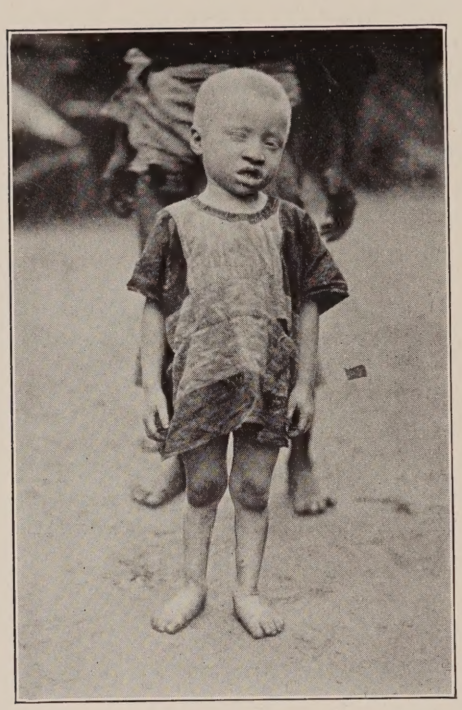
No. 274. — Case 133



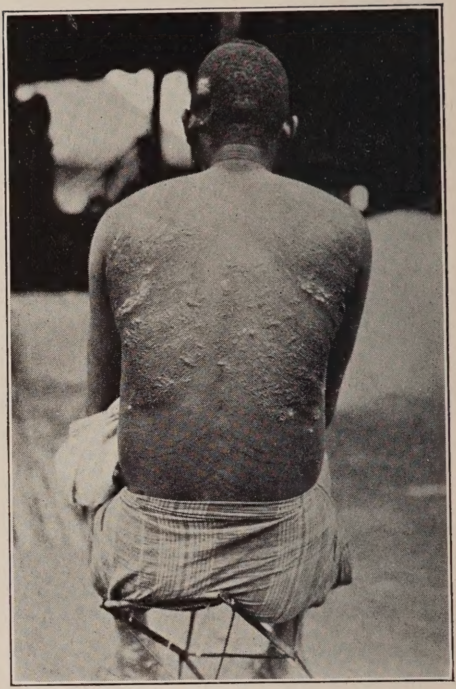


Nos. 275, 276. — Case 389

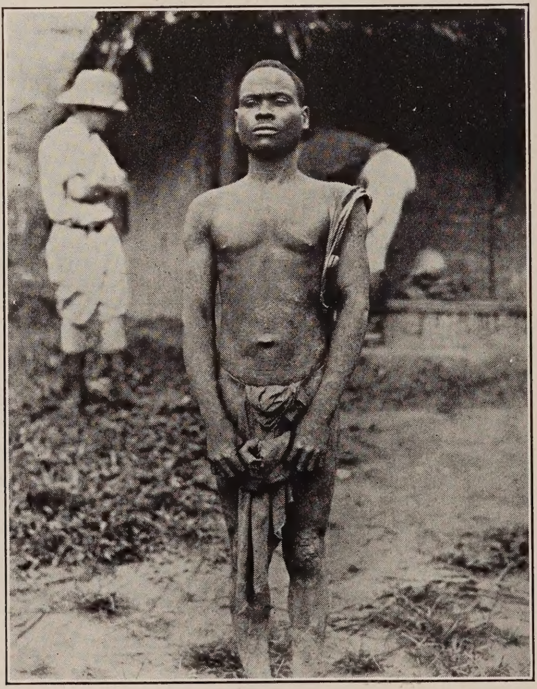
Vitiligo



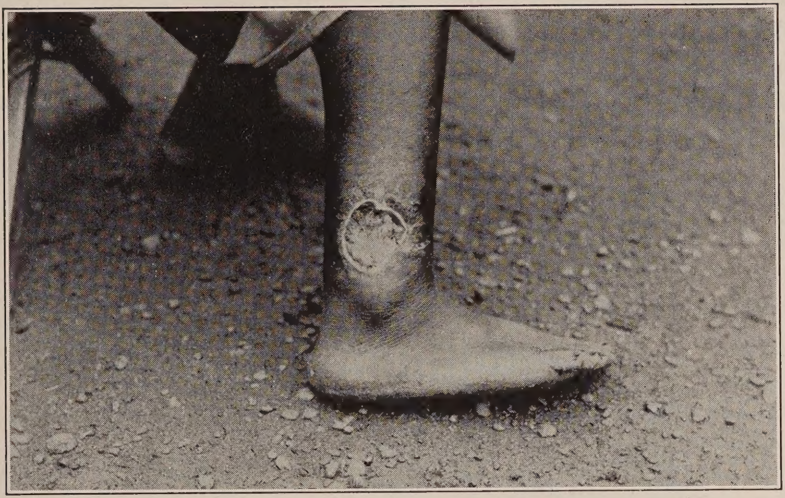
No. 277. — Albinism, Case 48



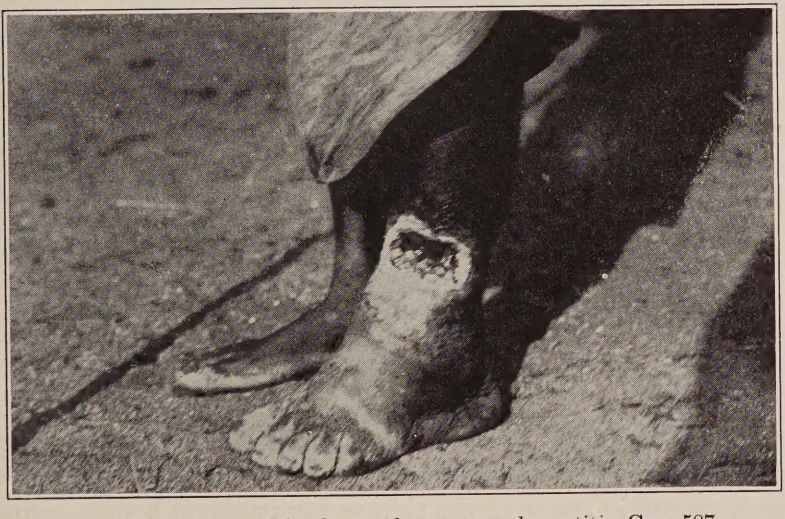
No. 278. — Seborrhoea, Case 192



No. 279. — Seborrhoea, Case 410

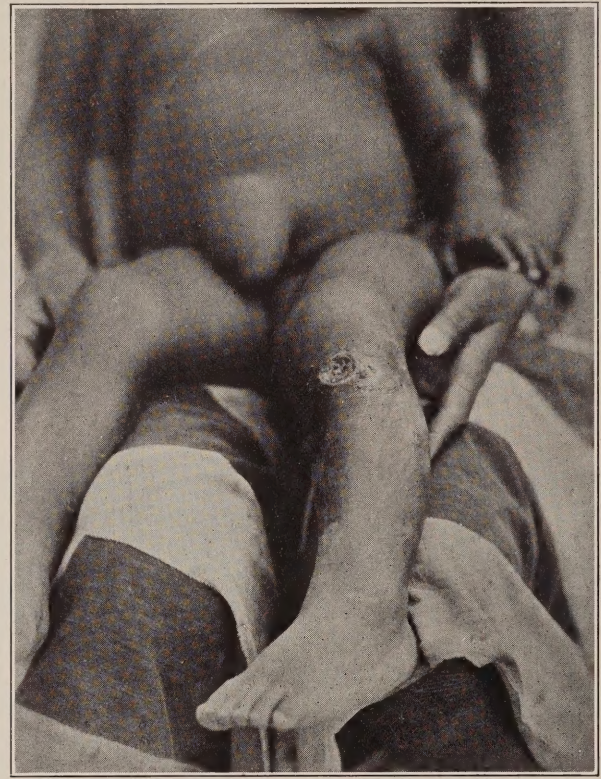


No. 280. — Phagedenic ulcer, Case 190



No. 281. — Phagedenic ulcer and verrucous dermatitis, Case 587

rhoea, are all forms of *Malassezia ovale* and that the flask bacillus of Unna and the morococcus represent different methods of reproduction of this fungus. Acton and Panja also report successful cultivation of this organism. In the beginning they tried in vain to obtain it in pure culture in ordinary media but the cultures were always so overgrown by staphylococcus that they were unsuccessful. It seemed clear to them that a medium was required that would inhibit the staphylococcus and which would contain fat. Successful cultures were finally obtained on Petroff's glycerinated medium, an egg medium containing gentian violet to the amount of 0.004 per cent. On this medium the primary cultures appeared as small, dry, chalky, white colonies visible to the naked eye about the third day. The fungus appeared in scales of the skin as flask-shaped bodies, round, swollen forms, smaller coccoid elements, and irregularly-shaped mycelia. They remark that this apparently is the first time that the organism has been cultivated.



No. 282. — Umbilical hernia and phagedenic ulcer,
Case 189

Tropical or phagedenic ulcers (Nos. 280–282) were also met with in Liberia as well as in the Congo, usually single and situated on the leg. However, tropical ulcer was not nearly as common as it is in some other parts of the tropics, Amazonia and the Far East, for example. The typical forms showed upon microscopical examination the usual appearance of large numbers of spirochaetes and fusiform bacilli, as well as cocci and sometimes other bacteria.

We have previously discussed the importance of *Spirochaeta schaudinni* and *Bacillus fusiformis* as an etiological factor in tropical or phagedenic ulcer.[1] From our observations and from those made by other investigators it seemed probable that *Spirochaeta schaudinni* cannot usually establish itself in healthy skin or even in many aseptic wounds, but after the epithelium is bruised, burned, or otherwise injured, the circulation interfered with, and the vitality of the tissues otherwise impaired so that necrosis occurs, it may then sometimes gradually assume pathogenic properties and a phagedenic ulceration result which assumes a chronic character. Some observers have inclined to the view that the spirochaetes and fusiform bacilli are merely saprophytic invaders. However, evidence is from time to time being produced, showing that these organisms are clearly capable of producing suppurative and necrotic lesions. Thompson[2] has very recently reported upon another case of fatal brain abscess (the third of such nature of which we have knowledge), following extraction of a second molar tooth. The spirochaetes and fusiform bacilli were found in the lesions in the mouth during life. At the necropsy, Thompson writes, an abscess was found in the sphenopalatine fossa, extending by way of the middle meningeal vein to the longitudinal sinus, both of which contained pus. There was an abscess of the right temporal lobe, moth-eaten in appearance, typical of Vincent's angina, and presenting Vincent's organisms, spirochaetes and fusiform bacilli on smear. There were abscesses in both orbits and there was thrombosis of the cavernous sinus with the spirochaetes and fusiform bacilli also present in both. The blood culture taken during life was negative after four days.

Dalrymple[3] has recently called attention to a possible dietetic origin for tropical ulcer in West Africa. After changing and improving the diet of the natives and providing for their use, hot and cold baths, the affection became much less prevalent among them. By diet and other hygienic measures he evidently improved the general health and resistance of the natives and rendered them less susceptible to infection. Phagedenic ulcer in its developed stage, is the result of an infectious process.

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[1] Strong: Spirochaetal Infections of Man. Atlantic Med. Jour. (May, 1926), p. 29.

[2] Thompson: Jour. A. M. A. (1929), XCIII, 1063.

[3] Dalrymple: West African Med. Jour. (1928), II, 133.

XXIV

OTHER PATHOLOGICAL CONDITIONS

Umbilical hernia was found to be very common in Liberia. It was frequently observed in young children but rarely noted in adults (No. 282). Apparently this condition usually develops from non-resistance of the umbilical scars which form after the umbilical cord drops off. The umbilicus then gradually becomes mechanically stretched. The hernia is probably especially favored by bad management at parturition followed in very early childhood by constant distention of the abdomen from eating coarse food. It would appear that many of the cases recover spontaneously during or before adolescence, but we cannot be sure of this fact. Inguinal hernia was rarely observed. Umbilical hernia was much more common in Liberia and parts of Africa than in tropical South America or the Far East. I have never observed so many cases on any previous expedition. Madden,[1] in his excellent article, Connor [2] in his book "Surgery in the Tropics," and Castellani and Chalmers in their comprehensive "Manual of Tropical Medicine," although they discuss inguinal hernia, do not refer to this condition of the umbilicus.

Neoplasms were not found to be common in Liberia. The tumors of parasitic origin have been discussed in Chapter XVII. Several cases were observed in which the clinical diagnosis was fibrosarcoma with no evidence of special malignancy. The largest of these occurred in a middle-aged negress. The tumor was located on the outer aspect of the lower leg in its upper third. It was rounded and the size and shape of a grapefruit. The greatest diameter of the tumor was 14 cm. and it projected 6.5 cm. from the leg. Microscopical examination of a few drops of fluid obtained by puncture with a needle revealed no parasites. The patient refused absolutely to permit excision of a piece of the tissue for histological examination. In another instance, in a well-developed and well-nourished man, a large mass was found projecting downward and outward for about 12 cm. below the ramus of the lower jaw. The tumor was not adherent to the skin and was slightly movable under the underlying structures. At Kisenyi an old woman was observed with a fungating mass at the ala of the nose which was apparently a carcinoma.

Several cases of cystic goiter were seen in Liberia and in the Congo. No evidences of hyperthyroidism were obtained (No. 287).

Intestinal infections. The common intestinal nematodes, *Ascaris, Oxyuris, Uncinaria* (*Ancylostoma*), and *Strongyloides* were found (as would be expected) both on the coast and in the interior of Liberia. In the school children of Monrovia and of Cape Mount the rate of hookworm infection was not below 45 per cent, while in the interior at Gbanga it was 84.6 per cent. The actual rate of infection was higher in all these instances because it was usually not practicable in these patients to make more than a single examination. The *Ascaris* infection in the different localities averaged about sixty-one per cent. Maass found in the northwestern border of Liberia about ninety-six per cent of the patients examined were infected with ancylostomes, and that the rate of *Ascaris* infection was only a trifle lower. We found that in spite of its prevalence severe cases of hookworm infection were not common in Liberia. The patients seemed to be not at all or very little affected by the infestation with the common intestinal parasites except in a few instances. Gordon [1] in his studies of the West African races made in Freetown, has previously called attention to this fact. He studied the effects of ancylostomiasis on the health of 137 natives, and those of *Ascaris* and *Trichuris* on 89 of the same cases, and showed that these infections, or a combination of them, produced no noticeable changes in the haemoglobin percentage, or in the physique and general fitness, or the mentality of the individuals examined; nor did he find that the presence of the parasite was associated in any way with albumin or casts in the urine. He also pointed out that the *Ascaris* and *Trichuris* infections did not appear to be associated with a low standard of energy, nor was the percentage of cases of ancylostomiasis, or the average degree of infection, necessarily noticeably greater in a group of individuals with a lower standard of energy than in one with a higher standard. However, in a few individuals severely infected, the possibility of some association between the ancylostomiasis infection and the low standard of energy was suggested.

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[1] Madden: "Practice of Medicine in the Tropics," ed. by Byam and Archibald, III, 2499.

[2] Connor: "Surgery in the Tropics," 1929; also Trans. Royal Soc. Trop. Med. and Hyg. (1928), XXII, 219.

The occurrence of *schistosomiasis* has already been referred to in Chapter XVI. It is very common in the interior of Liberia, but very rare on the coast, and Dr. Bouet believes that all cases seen in Monrovia have become infected inland. Maass found *Schistosoma haematobium* in northwestern Liberia, but did not observe *Schistosoma mansoni*. We have already noted the presence of both.

Dysentery is rarer in Liberia than in many tropical countries. While both amoebic and bacillary forms occur, the absence of large numbers of cases of dysentery in Liberia is striking. Enteritis was also seldom complained of by the natives and Dr. Shattuck found that when intestinal symptoms were complained of they could generally be attributed to gluttony.

Cosmopolitan Diseases

Smallpox occurs in Liberia and a case of the disease was seen by us near our camp on the Du River shortly after our arrival. This man was employed on the Firestone rubber plantations. In order to prevent the spread of infection among the other native laborers, all those employed in the vicinity were vaccinated, Dr. Willis, the physician in charge of the Firestone Plantations Company having arranged with us to perform these vaccinations. The pitted scars of smallpox are not uncommonly seen on the faces of natives of a number of tribes in the interior. Chickenpox was also observed in children in Liberia (No. 284).

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[1] Gordon: Ann. Trop. Med. and Parasit. (1925), XIX, 429.

At Lisala in the Belgian Congo a patient was observed with advanced tubercular leprosy who was also suffering with a well-developed exanthem of alastrim. Several other cases of alastrim were also seen at Lisala.

Tuberculosis and *gonorrhoea* are also among the *cosmopolitan diseases* common in Liberia. The former is not uncommon among the Americo-Liberians, but is apparently not prevalent among the tribes inland. Dr. Shattuck observed only one case of phthisis in the interior of Liberia which gave signs ordinarily present in advanced cases. Phthisis was said by the Government physician at Kinshasa to be very prevalent in the surrounding Belgian Congo, and that its prevalence in natives in the interior was directly proportional to their contact with whites. Dr. Shattuck thinks that it is probable that, as time goes on, phthisis will become far more prevalent among the natives in Africa than it is today, and that it may eventually cause a very high mortality. He thinks that it is not unlikely that a similar expansion of tuberculosis from the inhabitants of the coast to the tribes of the interior may be anticipated in Liberia.

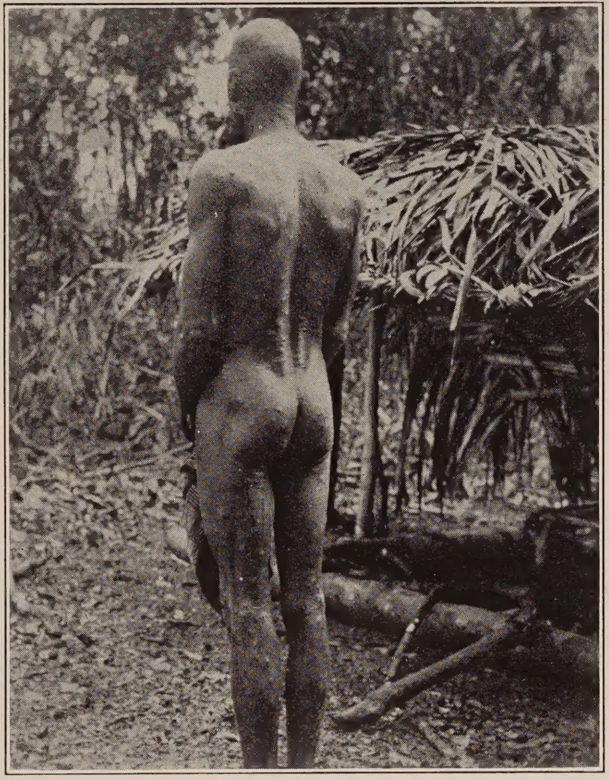
Gonorrhoea was particularly common among the people residing along the coast in Liberia and in those who had come in contact with them, but among the more isolated tribes of natives in the interior only one case (No. 353) of gonorrhoea was positively diagnosed by microscopic examination of the discharge. No cases of gonorrhoeal ophthalmia were seen among native children. Old lesions of the eyes, which were not infrequent, were apparently usually due to accidental injuries.

At Gbanga, where a number of men thought they were "woman sick," bilharzia ova were found in the urine.

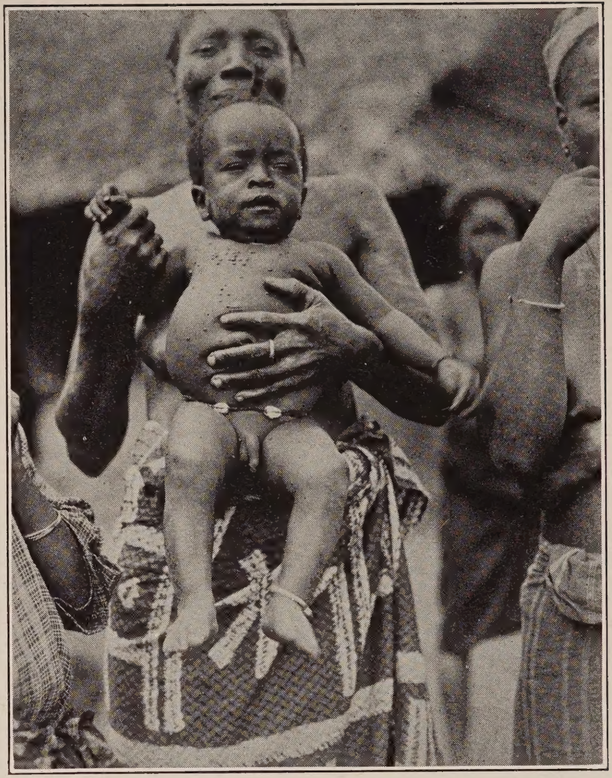
Buboes, unilateral or bilateral, were occasionally encountered, but chancroid, funiculitis, and hydrocele were rarely seen, while no typical case of granuloma inguinale was observed by us in Africa.

Dr. Shattuck found *circulatory diseases* scarce in Liberia. Typical cases of valvular disease of a rheumatic type were not met with, neither was a single case of the luetic type of cardiac disease nor of aneurysm recognized. Moreover, hypertension was not observed and peripheral arteriosclerosis was rarely noted. However, in one old woman marked sclerosis of some of the veins of the leg was observed. The few cases of cardiac insufficiency that were seen corresponded to no definite type of valve lesion. He thought that treponemiasis might perhaps have been the cause of such myocardial weakness. Nephritis was also found to be uncommon.

Acute rheumatic fever, like typical rheumatic heart disease, was not observed in Liberia. Cases of *arthritis* were not uncommon but they were of types that suggested either gonorrhoea or treponemiasis as the cause. In some instances, the cases of gonorrhoeal arthritis were typical, the gonococcus being obtained



No. 283. — Smallpox on the Du River

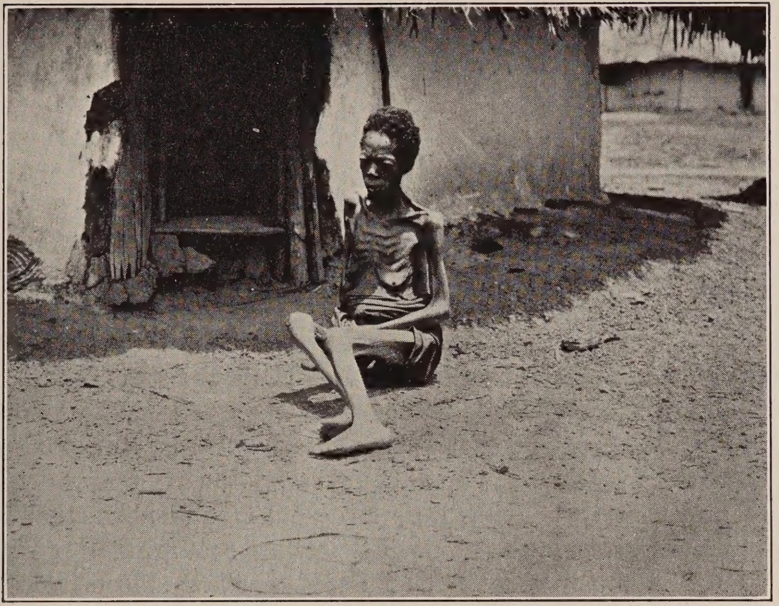


No. 284. — Chickenpox, Case 174

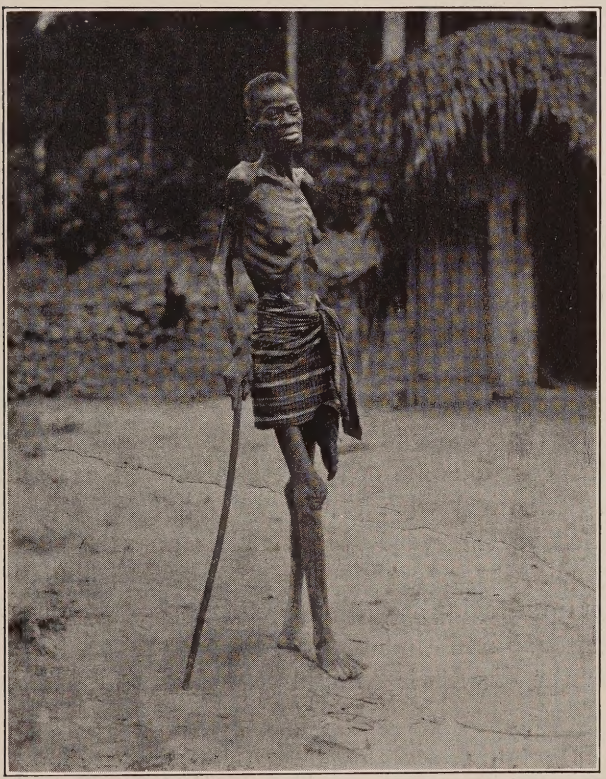
in the urethral discharge. A case of infective arthritis of doubtful origin was also seen.

Diseases of the nervous system were not often found in Liberia. Tabes and general paralysis were not observed. A single case of probable Parkinson's disease and several cases of probable poliomyelitis were encountered in Liberia, and several cases of the latter were seen also in the Congo. Syphilis of the central nervous system, which was observed in parts of the Belgian Congo, has already been referred to (page 281). A few cases of hypochondriasis, of neurasthenia and of hysteria were also met with among the natives in the interior of Liberia.

Many cases of *emaciation* were observed in Liberia, which condition, so far as we could ascertain, was frequently independent of infectious chronic disease. The diet of many of the natives in the interior is not one upon which a white man would probably long survive. The great scarcity of meat has already been referred to. Mandioca root, palm oil, rice, and bananas (quite green), are staple articles of diet when obtainable. Many of the cases of emaciation were undoubtedly of dietetic origin (No. 285). In other cases of emaciation the difficulty seemed to be due especially to poor teeth and inability to masticate the rough, coarse food. We were told in the interior that when a man's teeth became so poor that he could not eat the coarse native food it was about time for him to die. This view was to some extent confirmed by the relative scarcity of elderly people in the interior, and by advanced emaciation in many of them. Case 382 (No. 286) appears to be a case of chronic starvation largely due to lack of teeth. The patient was a negress of the Gio tribe. She seemed intelligent and alert and was well-developed in spite of extreme emaciation. She walked with a stick because of weakness. The mucous membranes were slightly pale and there was chronic iritis of the left eye. There were no teeth. The lymphatic glands were palpable but not enlarged. The pulse was slightly rapid, becoming more so on walking, when the heart impulse then became greatly increased in intensity and could be seen and felt in the sixth space of the anterior-axillary line. The pulmonic second sound was much accentuated. There were no murmurs. The lungs showed slightly tubular breathing and slight dullness with a tympanic quality, at the lower left back. A very few râles were heard at the base. The abdominal examination was negative. The liver and spleen were not palpable. Knee jerks were present. The blood examination for filaria and trypanosomes was negative. A thick smear of the blood showed considerable variation in the size of the red cells. The achromia was marked. No blasts were found and the leucocytes appeared to be normal in number and appearance. The emaciation could not be satisfactorily explained except upon the basis of gradual starvation from lack of nourishing food. Dr. Shattuck observed in Monrovia, a case of incrustation of the teeth which in his experience was unique in degree (No. 288). The lower incisors had become the shape and size of small dice. They were flat on the front, back, sides, and upper surface and there was marked pyorrhoea which had caused them to become loose. The patient, unfortunately, was



No. 285. — Case 346



No. 286. — Case 382

Cases of emaciation in Liberia

quite unwilling to spare one of the teeth. This patient also had elephantiasis of the scrotum and penis.

Beriberi occasionally occurs in the interior of Liberia and a case was observed there which, however, had apparently originated in Monrovia. Beriberi, however, is an uncommon condition in Liberia.

Neither relapsing fever nor bubonic plague were observed in Liberia.

Relapsing Fever. — *Ornithodoros* was not found in Liberia and has, indeed, not been reported on the West Coast of Africa. For its distribution, see map No. IX, page 813. Dyce Sharp[1] also points out that the tick-borne form of relapsing fever has never been recorded in British West Africa. However, in his article entitled "Epidemic Diseases in West Africa, the menace, of the future," he refers to the fact that sporadic cases of relapsing fever have been reported from time to time both in Nigeria and the Gold Coast. It seemed probable to him that these cases were louse-borne, and he further states that in his opinion the relapsing fever which is now scourging the West African native from Timbuctoo to the Bight of Benin was introduced from Europe by the returning French troops. He also refers to the investigations of Kerrest, Gambier and Bouron who traced the spread of the disease down the Niger from village to village. As an example of the danger of the extension of the infection he recalls the epidemic of relapsing fever which occurred in Accra on the Gold Coast in 1922. Caffrey[2] also points out that all the evidence available points to the disease being transmitted in Nigeria by the louse *Pediculus corporis*. The incidence reached its height in March when the relative temperature and humidity had risen, ideal conditions to favor the bionomies of *Pediculus*. Only a few cases were found during the season of heavy rainfall.

Riding[3] also refers to the fact that relapsing fever has been present in northern Nigeria and French Equatorial Africa for some years, having arrived there in all probability along the caravan routes from Morocco or Tunis.

Mathis, Durieux and Ewstiefeief[4] have recorded recently cases of relapsing fever occurring at Dakar in which the infection, in some, undoubtedly occurred in that city. They believe that the strain of spirillum isolated from these human cases behaved upon inoculation into animals more like the organism of tick fever than that of the louse-borne disease. The absence of *Ornithodoros* at Dakar suggested some other vector, as well as the possibility of the spirochaete being identical with the organism of the shrew *Spirochaeta crocidurae*. They believe that at Dakar there is an endemic focus of relapsing fever.

In a later communication Mathis[5] confirms the identity of the spirochaete of the shrew *Crocidura* and that of man in Dakar. He states that while the manner in which the disease is communicated at Dakar is still unknown, by

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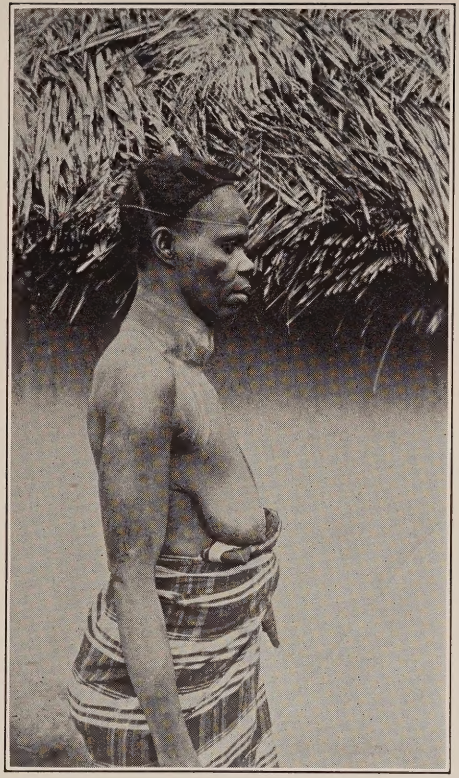
[1] Sharp: Trans. Royal Soc. Trop. Med. and Hyg. (1925–1926), XIX, 256.

[2] Caffrey: Trans. Roy. Soc. Trop. Med. and Hyg. (1926–1927), XX, 195.

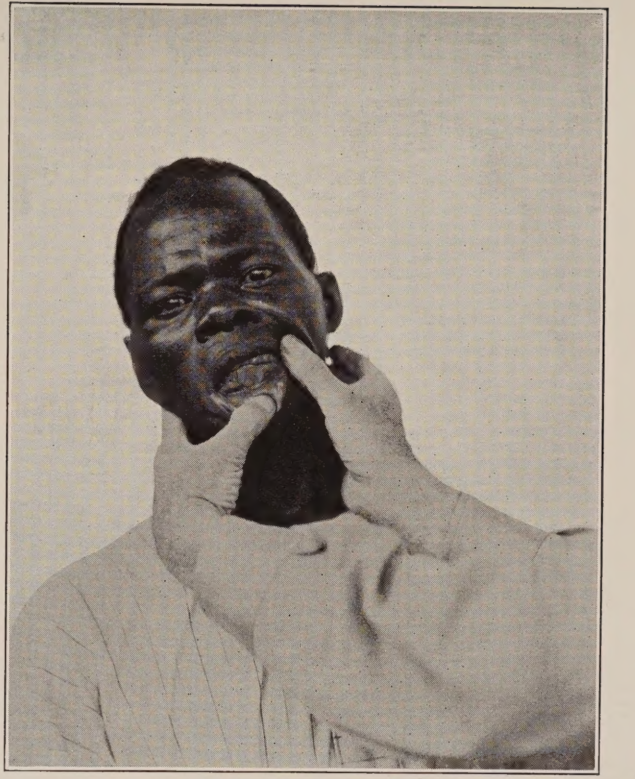
[3] Riding and Macdowell: Trans. Royal Soc. Trop. Med. and Hyg. (1926–1927), XX, 526.

[4] Mathis, Durieux and Ewstiefeief: Bull. Soc. Path. Exot. (1927), XX, 441; *Ibid.*, XX, 700.

[5] Mathis: C. R. Acad. Sci. (1928), CLXXXVI, pp. 46, 177; Bull. Soc. Path. Exot. (1928), XXI, 173.



No. 287. — Goiter in Kpwesi woman



No. 288. — Abnormal dentition in a Kru

searching the burrows of shrew mice he has succeeded in finding the nymphs of an undetermined species of tick which may be concerned in the transmission. He, however, transmitted the disease from monkey (*Cercopithecus patas*) to monkey, by means of lice. It may be recalled that Leger in 1917 found in the blood of the shrew in Dakar, *Crocidura stampflii* Jentink, 1887, a spirochaete to which he gave the name of *S. crocidurae*. This spirochaete which was identical morphologically with the spirochaete of recurrent fever was inoculated by Walker and Marie, with success, into two general paralytics.

Finally, after considerable further work on the subject, Mathis [1] as a result of cross immunity experiments, has come to the conclusion that the Dakar strain of spirochaete is identical with *S. duttoni*, and he agrees with Nicolle and Anderson in this respect, and that hence *Spirochaeta crocidurae* becomes a synonym of the latter species.

Schlossberger and Wichmann [2] who have studied this question also, come to the conclusion that *Spirochaeta crocidurae* is very similar to *S. duttoni* and at most can only be regarded as a variety or subspecies of it.

Although we found three species of *Crocidura* in Liberia, we do not believe that the conditions are such that relapsing fever is likely to spread from the hinterland into Liberia or to prevail in the interior of the country.

Along the route of our travel in the Congo from the northern end of Lake Tanganyika and in the vicinity of Lake Edward at altitudes of some 3000 feet, *tick fever* has been at times particularly common. The disease is also said to be spreading along the lines of communication radiating from these points and to be invading the higher country which was formerly free from the disease. Van Hoof [3] has very recently called attention to the prevalence of the disease along the route from Irumu to Lake Edward, and Limbor [4] has noted its extent in Urundi. The affection in these regions is known as *kimputu*. While *Ornithodoros* was collected by us from a number of the resthouses along our route, from Tanganyika northward to Lake Albert, special precautions against infection were taken and none of the members of the Expedition were attacked by it.

It may be recalled that it was at Moera, in the Ituri Forest, near Irumu, a route that we followed, that the Prince of Sweden became infected with *kimputu* and was so seriously ill that he had to cut short one of his very important zoological and botanical expeditions in these regions.[5]

Bubonic plague is not endemic in Liberia and no cases of the disease were observed there. The fact that there is no harbor in which ships may be anchored and that they must lie out beyond the surf has evidently served as a barrier to the escape of plague-infected rats from ships to the shore.

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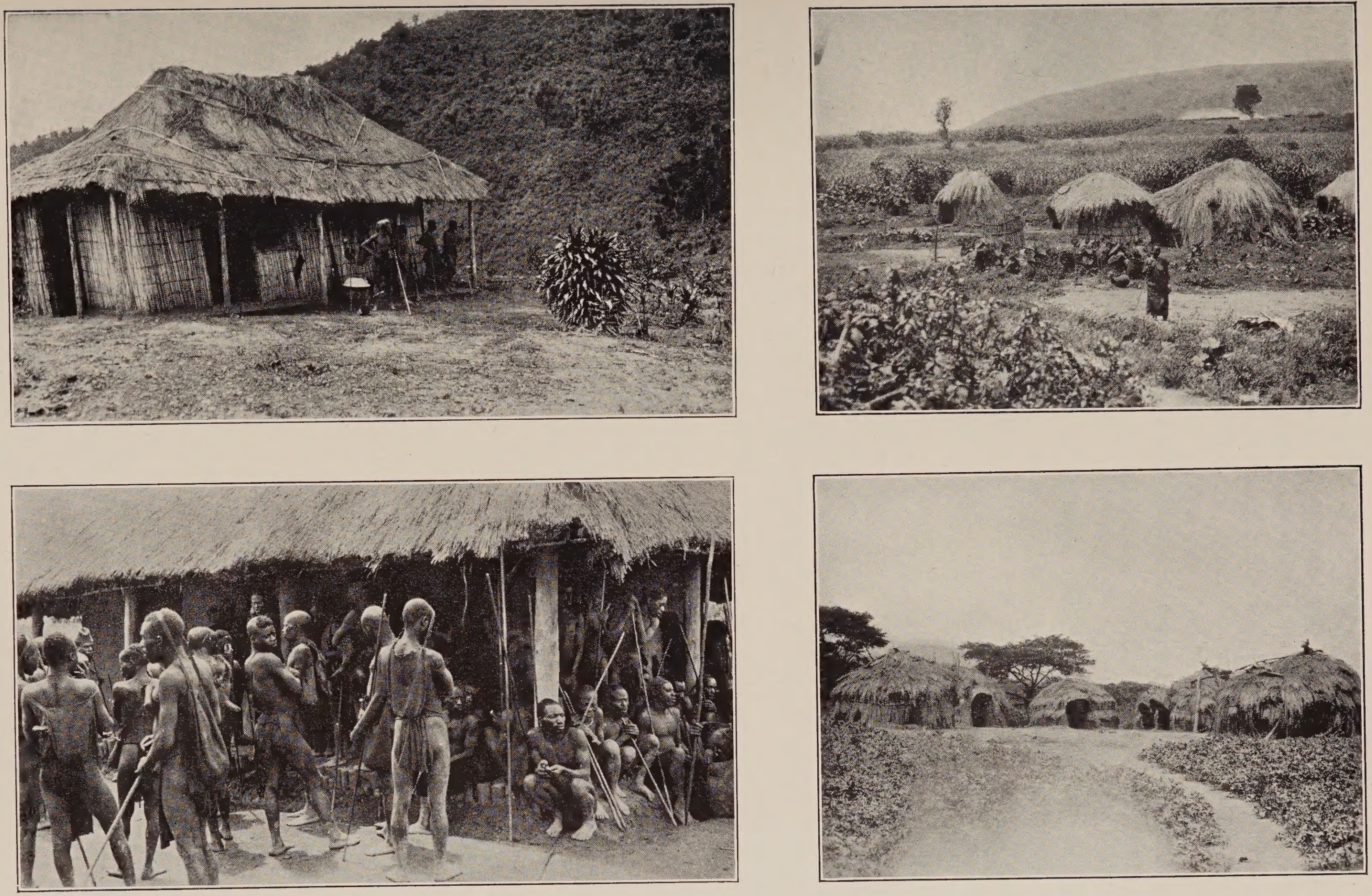
[1] Mathis: Bull. Soc. Path. Exot. (1928), XXI, 472.

[2] Schlossberger and Wichmann: Zeitschr. f. Hyg. u. Infektionskr. (1929), CIX, 493.

[3] Van Hoof: Final Report, League of Nations Internat'l Commission on Human Trypanosomiasis. Geneva (1928), p. 335.

[4] Limbor: Ann. Soc. Belge Méd. Trop. (1929), IX, 45.

[5] Prince William of Sweden: "Among Pygmies and Gorillas with the Swedish Zoological Expedition to Central Africa." London (1923), p. 228.



Nos. 289–292. — Resthouses and villages of the type in which the vector of Kimputu abounds

Allen (see Chapter XXXIII), in his study of the rodents of Liberia, notes that *Mus rattus* Linné, the (European) black rat, is occasional but less abundant than the gray rat. He found examples and notes its occurrence as far inland as some fifteen miles in the interior up the Du River. Several specimens were collected from native houses. He further noted that *Mus alexandrinus* the gray roof rat, swarms about the native villages, where it lives chiefly in the thatched roofs of the houses by day, and at night ventures forth in search of food. In many of the houses the rough ceiling formed by cross poles or split palm constitutes a refuge for rats. Exactly how these rats have reached even remote villages, separated from their neighbors by miles of forest, is difficult to see, unless they have been transported by persons carrying baggage, though it is possible that they may follow along streams and trails to some extent. He also points out that *Mus norvegicus* is found in Liberia, but that it is much less common than the roof rat.

In all, seventeen species of rats and mice were found in Liberia. Should a focus of bubonic plague at some time become established in Monrovia, opportunity for its spread would be afforded by the abundant rodent population. A species of *Xenopsylla* was also found in Liberia. Sporadic cases of plague have occurred during the past year on the West Coast of Africa, in Senegal, Nigeria, and Angola.

XXV

TRYPANOSOMIASIS

Sleeping sickness cases were first observed on the west coast of Africa, and in 1803 Winterbottom gave an interesting account of the symptoms of the disease, as he observed them, near Sierra Leone.

Johnston[1] and Maughan[2] have both referred to the occurrence of sleeping sickness in Liberia and Johnston states that it became noticeable early in the nineteenth century, and that Doala Bukere, the inventor of the Vai alphabet, died from this disease. To the affection the local name of *konje-kira*[3] was applied. The Vais evidently had an exceedingly vague idea of the malady since this term may be translated as "ball sickness" or "gland sickness," or perhaps even as "kidney sickness." Nevertheless, in the case of Doala Bukere the disease was said to produce in him such extraordinary drowsiness that he often fell asleep while taking his meals. Johnston also gives a colored photograph of a Mandingo of healthy appearance whom he states died of sleeping sickness some time afterward (in 1905).

It may be recalled that it was not until 1903, after Castellani, Bruce, and others, had demonstrated that a trypanosome was the cause of sleeping sickness, that we had in the demonstration of this parasite in the patient, a definite and convincing proof of the diagnosis of the disease. While from a clinical standpoint, then, sleeping sickness had been recognized in early years in Liberia, nevertheless, the diagnosis had not been made microscopically, and trypanosomes apparently had not been demonstrated in Liberia either in tsetse flies or in human beings prior to the present Expedition. In one of the wild flies, *Glossina palpalis*, captured at Tappi Town, Liberia, trypanosomes were found in the microscopical examination of fresh and stained preparations made from the dissection of both the gut and from the head segments of the fly. This, however, was the only *Glossina* found infected among all the tsetse flies which were caught and examined about this village. No human cases of trypanosomiasis were found in this district. Theiler, however, who examined ten children who were brought to him when he inquired for cases of *konje-kira*, found in five of them trypanosomes in the films made with fluid obtained from the lymphatic glands by puncture. These cases were observed about and between the villages of Bakratown and Paiata. They are referred to in greater detail on page 497. Human trypanosomiasis is evidently very rare in Liberia. Dr. Bequaert in the entomological report has described the species and the localities in which *Glossina* were found in Liberia.

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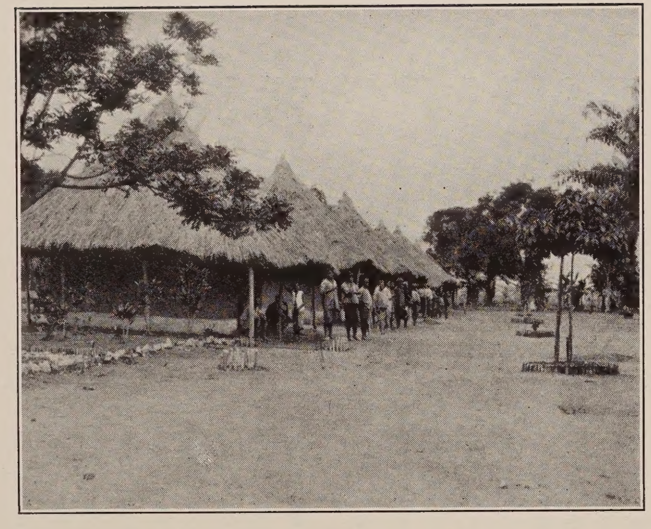
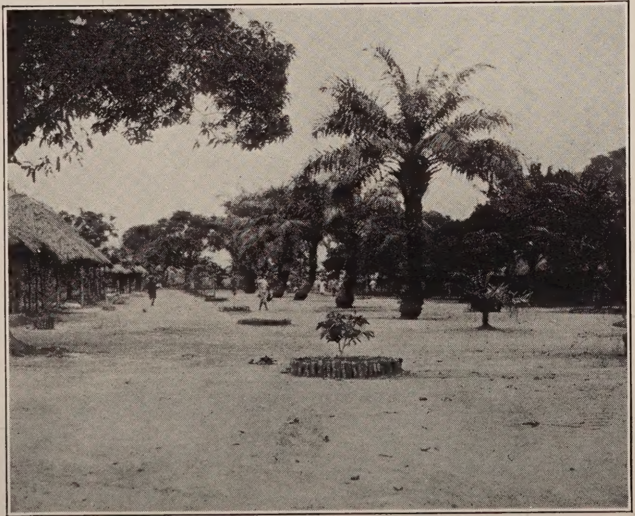
[1] Johnston: *Loc. cit.*, p. 986.

[2] Maughan: *Loc. cit.*, p. 287.

[3] The Kpwesi word for "konje-kira" is "ptauli."





Nos. 293, 294. — Sleeping sickness lazaretto, Kinshasa

Nos. 295, 296. — Sleeping sickness cases at Kinshasa

Animal trypanosomiasis is also apparently rare in Liberia. We were not able to make extensive blood examinations on account of the very few horses and relative scarcity of cattle and wild game in the country. However, in none of the animals (horses, cattle, and small wild game) examined, were trypanosomes found.

Bouet [1] who has investigated the subject of trypanosomiasis of animals in the territory of the lower Ivory Coast adjacent to Liberia, found cattle, sheep, goats, pigs, and dogs infected. The trypanosome which was regarded as *T. dimorphon* was common in cattle, fairly common in dogs and pigs, but rare in sheep and goats. He was able to infect monkeys with this trypanosome, and to transmit the infection in one experiment to a dog by means of *Glossina palpalis*.

Observations in the Congo. While trypanosomiasis is so rare in Liberia, numerous opportunities to observe the disease were found during the Expedition in the Congo, particularly about Kinshasa and Leopoldville, through the courtesy of Dr. Van den Branden, Dr. Duren and Dr. Mouchet; about Brazzaville, through the courtesy of Dr. Ledentu; about Tshumbiri, through the courtesy of Mr. and Mrs. Paul Metzger;[2] about Coquilhatville, through the courtesy of Dr. Strada; about Stanleyville and Yakusu, through the courtesy of Drs. Donadio, Chesterman, and Todd. In the Semliki Valley and at New Beni, cases of the disease were also observed. Finally, through the courtesy of Dr. Duke, we had the opportunity to visit and meet the other members of the League of Nations International Commission on Human Trypanosomiasis at Entebbe. The excellent studies and reports which have been issued recently by this Commission have added particularly to our knowledge of this distressing disease,[3] although some of their recent studies upon sleeping sickness do not yet appear to have become widely known.

Differentiation of Trypanosomes. In all of our textbooks of tropical medicine, and in the latest work published on protozoology by Wenyon, as well as in Rogers' new book published in 1928 on recent advances in tropical medicine, two varieties of sleeping sickness in man are described. The first is said to be due to *Trypanosoma gambiense* and transmitted through the bites of the tsetse fly, *Glossina palpalis*. The second is described as a more acute and deadly type produced by *Trypanosoma rhodesiense* and transmitted by the bites of *Glossina morsitans*. However, it seems to be questionable whether there really are two distinct human trypanosomes transmitted by different species of tsetse flies. The *Trypanosoma rhodesiense* of the more virulent disease has been said to be distinguishable from *T. gambiense* by the fact that it produced posterior nuclear forms when inoculated into small laboratory animals, while *T. gambiense* did not do so. However, such morphological differences have not been substantiated and the posterior nuclear forms may be sometimes observed in either *Trypanosoma rhodesiense* or *T. gambiense*. Indeed these posterior nuclear forms apparently result particularly from very rapid multiplication of the trypanosomes in the blood and hence vary

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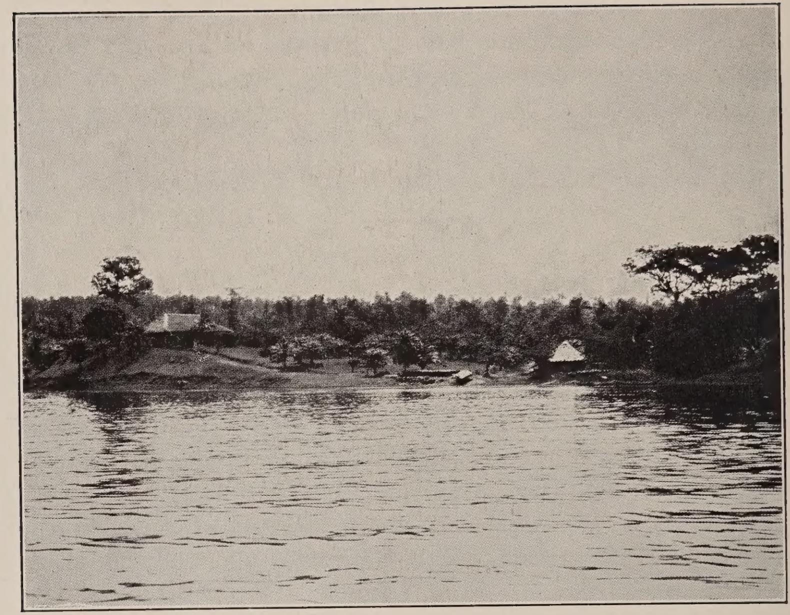
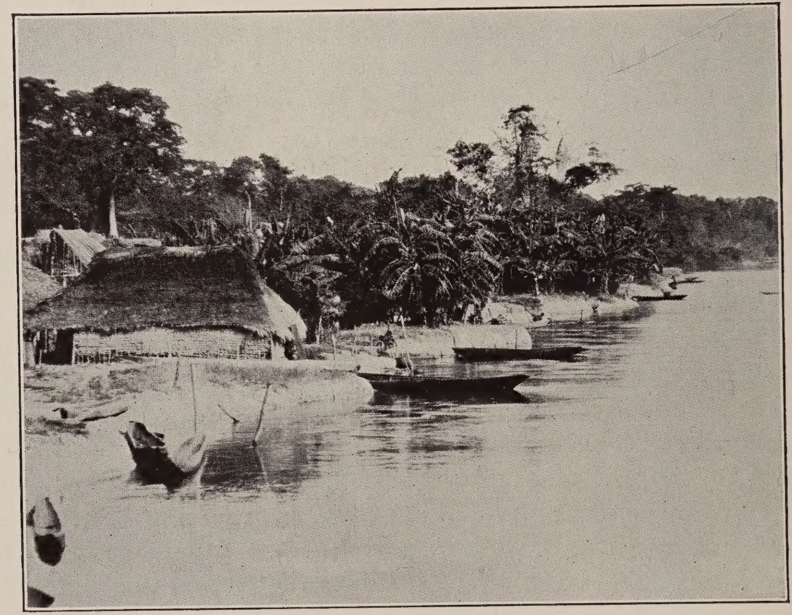
[1] Bouet: Ann. Inst. Pasteur (1907), XXI, 468–474, 969–982.

[2] Mr. Metzger himself had suffered from trypanosomiasis and been successfully treated for it.

[3] Duke, Kleine, Lavier, Prates, Peruzzi, and Van Hoof: Final Report of League of Nations International Commission on Human Trypanosomiasis. Geneva (1928).

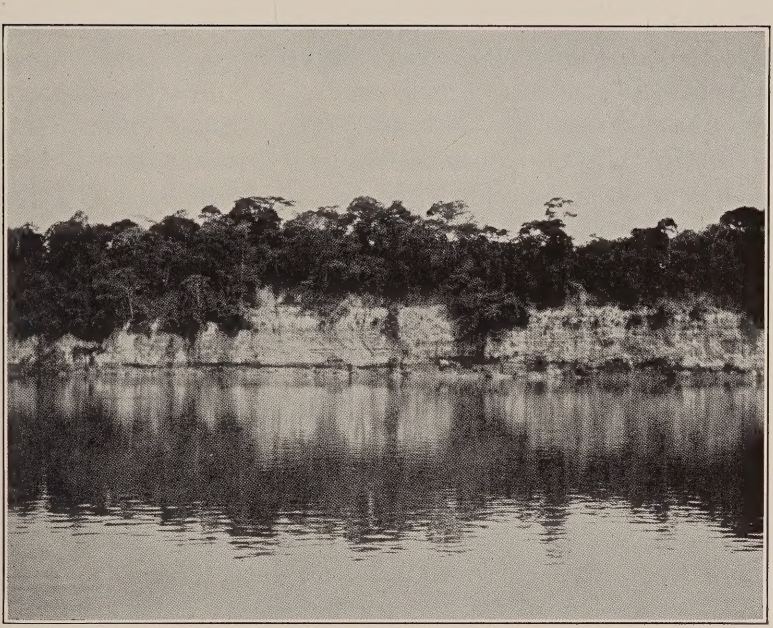


No. 297. — Congo River, near Bumba



No. 298. — Barumbu, approximately half way across Central Africa

Routes of travel in the Belgian Congo



No. 299. — Nearing Stanleyville

No. 300. — Ponthierville to Kindu
Routes of travel in the Belgian Congo

in number with the virulence of the trypanosome. From the available evidence one can only conclude that sometimes *T. rhodesiense* is a more virulent strain of trypanosome than *T. gambiense* but is similar to it in other respects. During the past year Duke, Kleine, and Lavier, of the League of Nations International Commission on Human Trypanosomiasis, have concluded that not only may posterior nuclear forms be found in *T. gambiense,* but that the difference between the two human parasites is not yet established.[1]

Many observers have suggested that *T. rhodesiense* is also identical with *T. brucei,* the common parasite of nagana of horses and cattle and of large game in Africa. Indeed, Bruce, Kinghorn and Yorke and several other investigators regarded the two as identical. Apparently the great objection that has been made to this opinion is that *T. brucei* in wild animals and *G. morsitans* have a very much wider distribution than *T. rhodesiense* in man. Duke has described a human epidemic of sleeping sickness which he believed was due to a lack of wild game in the vicinity, the tsetse fly being driven to attack man for food. Infection was said to be always traced to contact with the previous human case and was said to be direct by the fly, no cyclical development of the trypanosome in the gut of the fly and transmission to the salivary glands occurring.

Dye [2] has also reported upon the study of a similar local epidemic of trypanosomiasis in a village in Tanganyika Territory. His study convinced him that the source of the infection was man and that game animals played no part in the spread of the disease, the *Trypanosoma rhodesiense* being conveyed directly from man to man by the bite of the fly. Van Hoof [3] also in an epidemiological inquiry involving the examination of more than 45,000 natives, came to the conclusion that there was nothing to suggest that there was any other reservoir of the virus than man.

It is important to recall that Taute and Huber were unable to infect 131 men with trypanosomes by inoculating them with the blood from four horses and two mules, containing *T. brucei.* Nevertheless, it seems not unlikely that the trypanosome of human sleeping sickness is probably the same species as that which infects certain animals, notably wild game, but that it is a species which has become gradually accustomed to a new environment and finally specially adapted to life in the blood of man. Man is probably by the natural mode of infection immune to the trypanosomes of animals. It is perhaps only in those instances in which an individual especially susceptible becomes infected through a large number of virulent trypanosomes that the trypanosome becomes adapted to life in human blood and then may more frequently infect other human beings. The idea is not impossible that a somewhat similar relationship may sometimes occur in connection with the malarial parasites of human beings and of monkeys. Duke [4] points out that monkeys are much more susceptible to the pathogenic action of *Trypanosoma gambiense* than are ruminants and that monkeys are apparently even more susceptible than man. On the other hand, the baboon is apparently not susceptible to infection. Lavier [1] has recently tried to lower the resistance of baboons in order to infect them with *T. rhodesiense* by first infecting them with various helminths, *Treponema duttoni* and tubercle bacilli. However, he was not able to break down their immunity by these measures so that he could infect them successfully with trypanosomes. There is no doubt but that in a number of districts where *G. morsitans* prevails, the wild fauna harbor to some extent a trypanosome thought to be *T. brucei*. In some regions it has been said that from twenty-four to thirty-one per cent or even fifty per cent of the wild game are infected with trypanosomes, and that in many instances the parasite is regarded as *T. rhodesiense* (see also Buchanan, page 453 of this Report).

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[1] Maclean: (Ann. Trop. Med. and Parasit., Dec. 1929, XXIII, 519) has recently observed and described posterior nuclear forms in a strain of *Trypanosoma brucei.*

[2] Dye: Trans. Royal Soc. Trop. Med. and Hyg. (1927), XXI, 187.

[3] Van Hoof: Interim Report, League of Nations Intern'l Commission on Human Trypanosomiasis, Geneva (1927), p. 103.

[4] Duke: Parasitology (1928), XX, 427.

No. 301. — The Congo from Kongolo to Kabalo, *Borassus* palms along the bank

In the sitatunga (*Tragelaphus spekei*) it has been admitted that *T. gambiense* has been encountered (Duke), and practically all other antelopes have been experimentally infected.[2] The antelopes, however, frequently become immune to any action of the parasite and merely serve as a reservoir for the infection. Although a number of observers failed to find a natural reservoir host for *T. gambiense* among antelopes, except in the case of the sitatunga, they believe that antelope and such game generally may act as the reservoir for *T. rhodesiense* (*brucei*). Monkeys, hyenas, and buffaloes have also been found infected with *T. gambiense*. How virulent the trypanosomes of wild game are for man has not yet been determined, and no human inoculations with them, such as Taute

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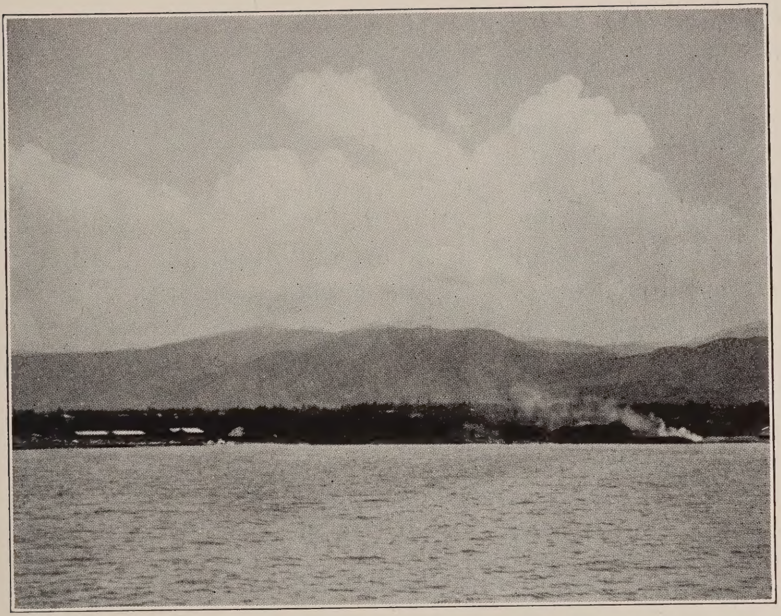
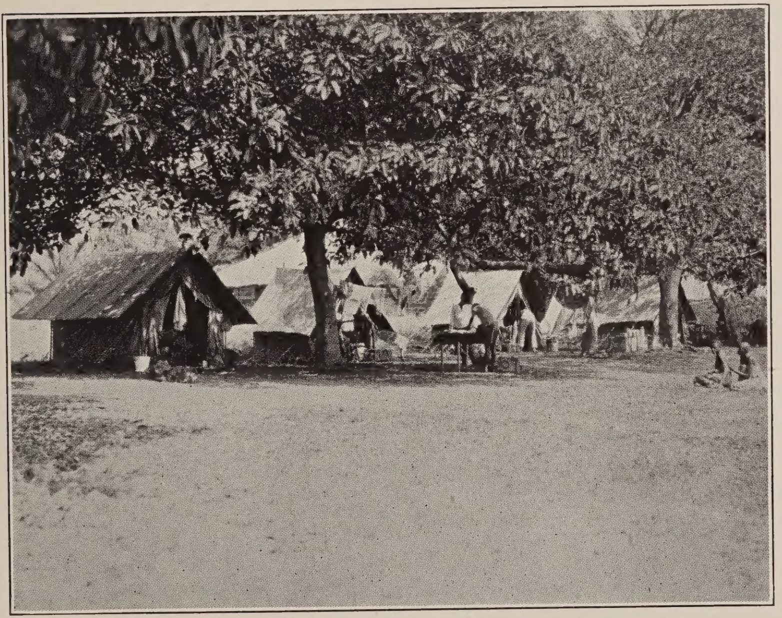
[1] Lavier: *Loc. cit.*, p. 119.

[2] Wenyon: "Protozoology" (1926), I, 538.

Nos. 302–304. — Medical clinics held along Lualaba River



No. 305. — Usumbura on the northeastern border of Lake Tanganyika



No. 306. — Camp at Kisenyi on the northern border of Lake Kivu

performed with the trypanosome of horses and mules, have been made. The subject of animal trypanosomiasis is discussed in Chapter XXVII, page 448.

Diagnosis. In many cases of human trypanosomiasis, in contradistinction to many cases of animal trypanosomiasis, it is exceedingly difficult to find trypanosomes in the blood. While the number of trypanosomes is subject to fluctuation, it, however, is true that exceptionally in trypanosomiasis in animals the parasites are rare in the blood, and, on the other hand, occasionally in trypanosomiasis of man, are plentiful in the blood. As an example of the latter condition, Connell [1] has recently called attention to the unusually large numbers of trypanosomes that were present in a single human case, sometimes as many as three or four being seen in the oil immersion field. Kleine [2] has also very recently seen human cases where the trypanosomes were numerous in the peripheral blood. Nevertheless, it is a well-known fact to those who are familiar with sleeping sickness in man, that in human beings as a rule there is difficulty in demonstrating trypanosomes in the circulating blood. This fact was especially emphasized to us on the present Expedition and we soon found the futility of making microscopical examinations of the blood for the diagnosis of many of the human cases of trypanosomiasis. In many instances, puncture of the slightly enlarged cervical lymphatic glands, and low power microscopical examination of the gland juices from the end of the hypodermic needle used for puncture, will reveal the presence of trypanosomes by their movement, when they cannot be found in the blood. Even in material from the glands, however, the number of trypanosomes may be exceedingly small and a search of an hour or more may be necessary before a single parasite is seen.

Some of the native microscopists in the Belgian Congo have become wonderfully skillful in the diagnosis of trypanosomiasis by microscopical examination. They usually make use of a low power objective and search first for movement among the red blood corpuscles, such movement suggesting the presence of trypanosomes, and they will occasionally find one after an hour or more of search and demonstrate it.

The trypanosomes are so very scanty in the blood as a rule that there is only a chance of finding them in fairly large numbers in advanced cases of the disease after centrifugation, when they sometimes also may be found in the centrifuged cerebral spinal fluid.

Prevalence. With reference to the distribution of sleeping sickness in Africa, it still prevails in the Belgian Congo, particularly in the Kwango, Kasai, and Semliki districts. Thus in the Belgian Congo, Schwetz [3] reports in the Kwango and Kasai districts, that 45,000 cases were detected in a population of 550,000. In the French African territory, G. Martin [4] in the examination of a half million inhabitants found 28,500 cases, or about five per cent of infection in the population. Blanchard and Laigret [5] reported in 1926 that the disease particularly

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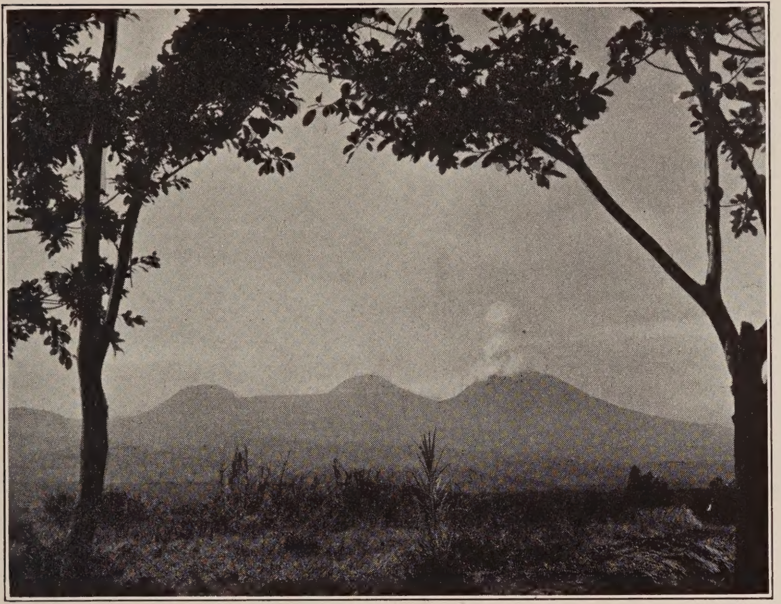
[1] Connell: Tanganyika Territory Ann. Med. & Sanit. Report (1926), p. 112.

[2] Kleine: Final Report, League of Nations Intern'l Commission on Human Trypanosomiasis. Geneva (1928), p. 9.

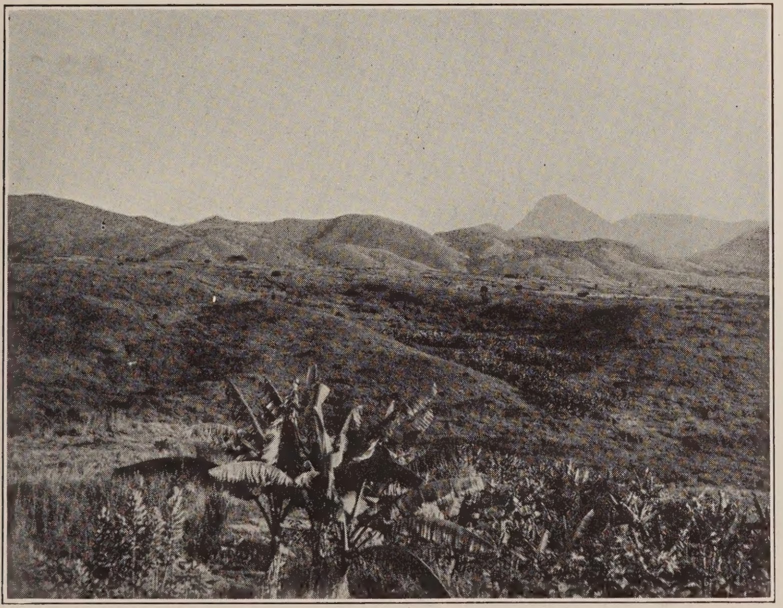
[3] Schwetz: Bull. Soc. Path. Exot. (1924), XVII, 76.

[4] Martin, G.: Trop. Dis. Bull. (1924), XXI, 50.

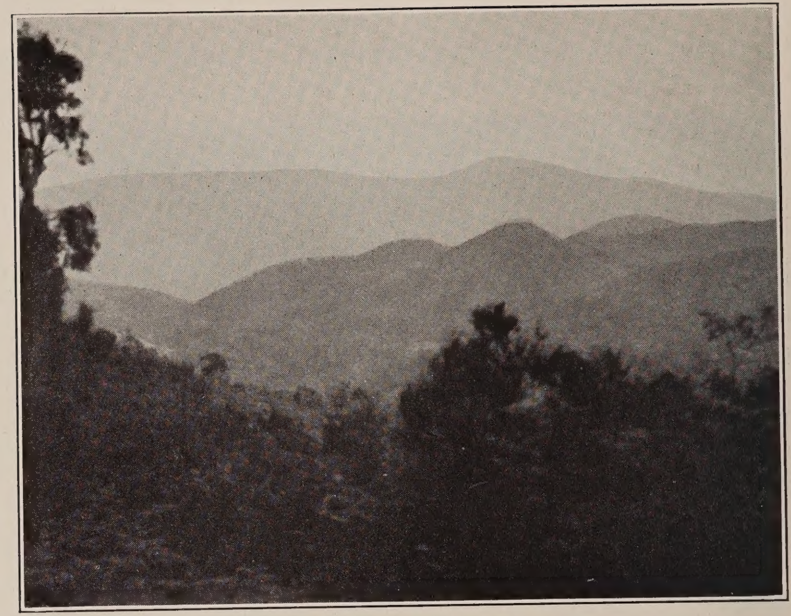
[5] Blanchard and Laigret: Ann. Méd. et Pharm. Colon. (1926), XXIV, 67.



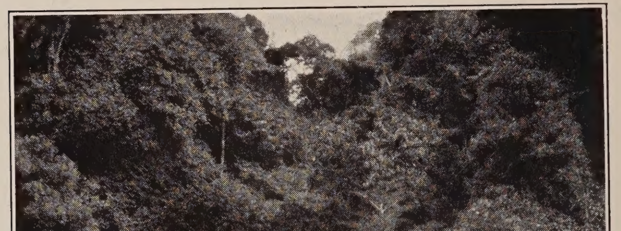
No. 307. — Mikeno and other volcanoes from the trail approaching Ruchuru



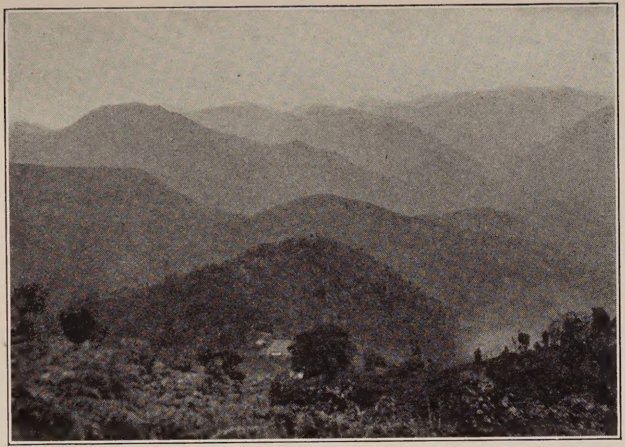
No. 308. — Trail northward from Ruchuru



No. 309. — Trail between Luofu and Lubero

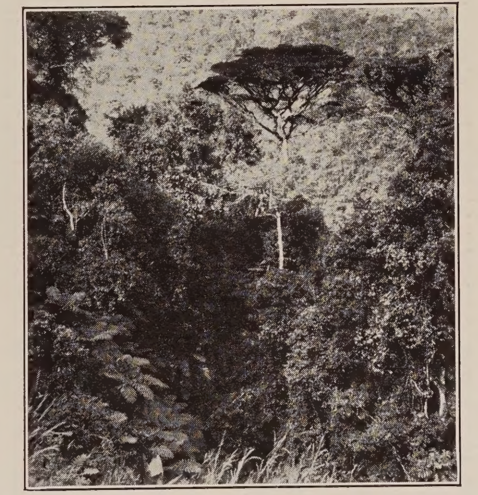


No. 310. — Trail between Lubero and Kayumba



No. 311. — Between Kayumba and Geleza

No. 313. — Country near Beni



No. 312. — Between Kabiabu
and Karimbumba

No. 314. — Ituri Forest on
trail from Shamba

Country and route of travel northward to New Beni prevailed in the upper Ogowe region in Gabon, where thirty per cent of the inhabitants were infected. In the Chad colony the infections were estimated at seven per cent of 1,500,000 inhabitants, with an average yearly death rate of 25,000. In the Cameroons, Tamon and Jamot found that of 100,000 natives examined through several years, 30,000 were infected, the percentage of infected in the different districts varying from eight to forty-eight per cent.

In a more recent report of Jamot,[1] for the Cameroons, it is pointed out that from October 1926 to November 1928, 81,063 new cases of infection were seen, which makes a total of 115,354 people infected with trypanosomes for a population of 663,971 inhabitants, or an average of 17.46 for 100 inhabitants. On the other hand, infection with trypanosomiasis among white people in Africa is very rare. Van den Branden [2] (1928) in reporting upon the first medical cruise of the hospital ship "Belgique" upon the Congo River between Leopoldville and Kwamouth, found only one European infected in this region. In all, 3,778 natives were examined in 52 villages and 168 new cases of trypanosomiasis were discovered; 620 cases were also found undergoing treatment. Also, in many parts of Africa where sleeping sickness was formerly said to prevail, it is no longer a serious problem. Thus Van Hoof, who has made an epidemological inquiry regarding the diseases of the Budama district and the Kavirondo north of Lake Victoria which involved the examination of more than 45,000 natives, concluded from a careful village to village inquiry that sleeping sickness played a distinctly minor part in the general mortality as compared with infant mortality, which was still the chief obstacle in the development of the races.

We observed no cases of sleeping sickness in our journey from Yakusu northward to Lake Edward. The plains of Ruchuru and the Ruindi south of the Lake, and the lower country at the northern end as well, are "closed" because trypanosomiasis formerly prevailed there, and it was necessary to obtain special permission to enter these closed localities. In the vicinity of the Ruchuru River there were many small villages and no cases of trypanosomiasis were recognized in them, although no general search was made for it. There is no hospital at Ruchuru. The diseases regarded as most common there were malaria and tick fever.

While we were on the plains, between February 2nd and early March, there was practically no rain and tsetse flies were seen rarely, except upon game which we shot. We left the plains on April 25, after there had been more or less rain for six weeks, and tsetse flies were still not abundant. Captain Catchpole, an English hunter, said that before the dry season there had been swarms of tsetse flies among the bushes along the banks of Lake Edward. Trypanosomes were not found in any of the wild game shot in these regions, though blood specimens were always taken.

At New Beni (Bungulu) at the edge of the Semliki Valley, prisoners were shown us as suspected cases of trypanosomiasis. Gland palpation and puncture were performed and blood smears were also examined and all were negative.

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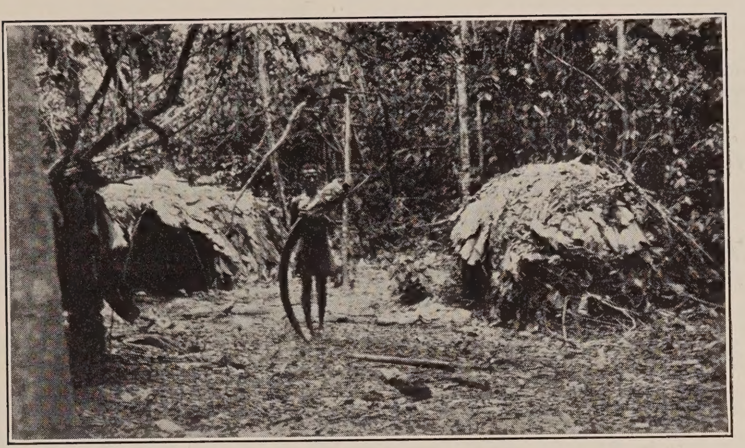
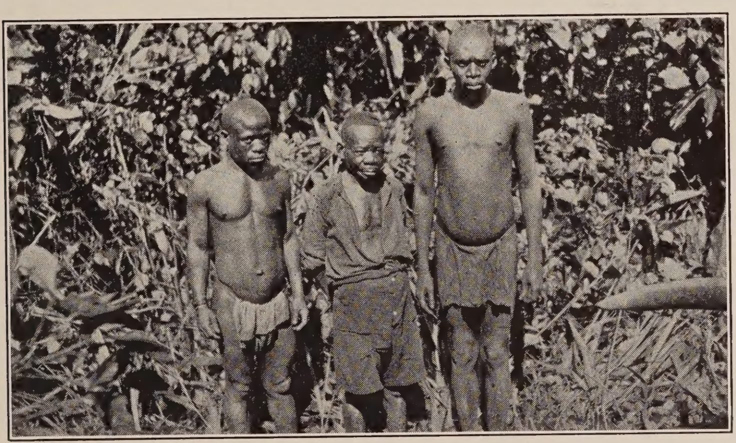
[1] Jamot: Bull. Soc. Path. Exot. (1929), XXII, 481.

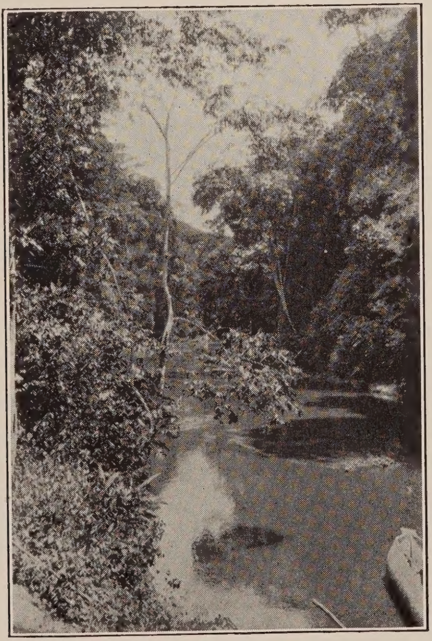
[2] Van den Branden: Ann. Soc. Belge Méd. Trop. (1928), VIII, 197.



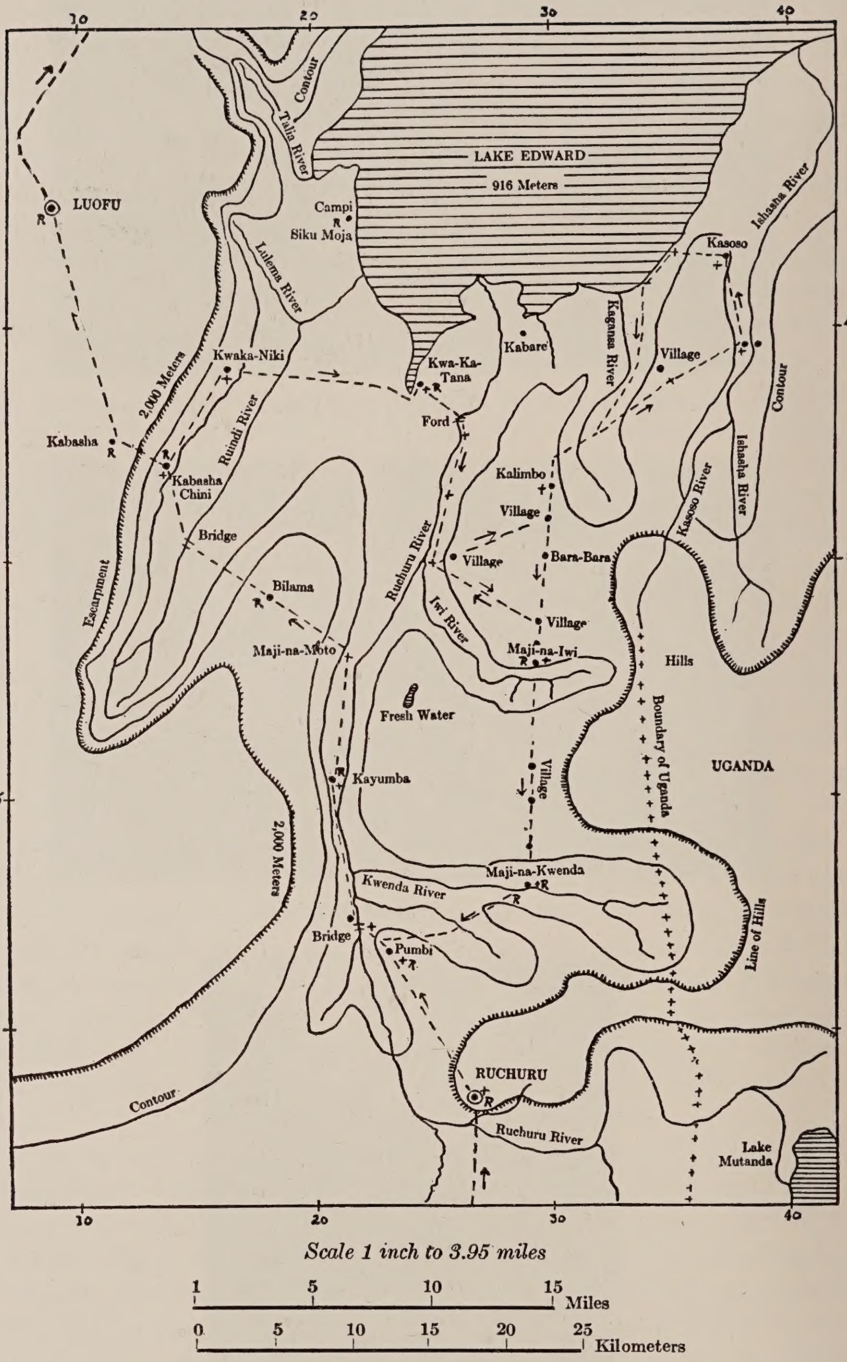
No. 315. — Ituri Forest, Wambuti pygmy village near Ingerosa



No. 316. — Wambuti pygmies



No. 317. — Loya River

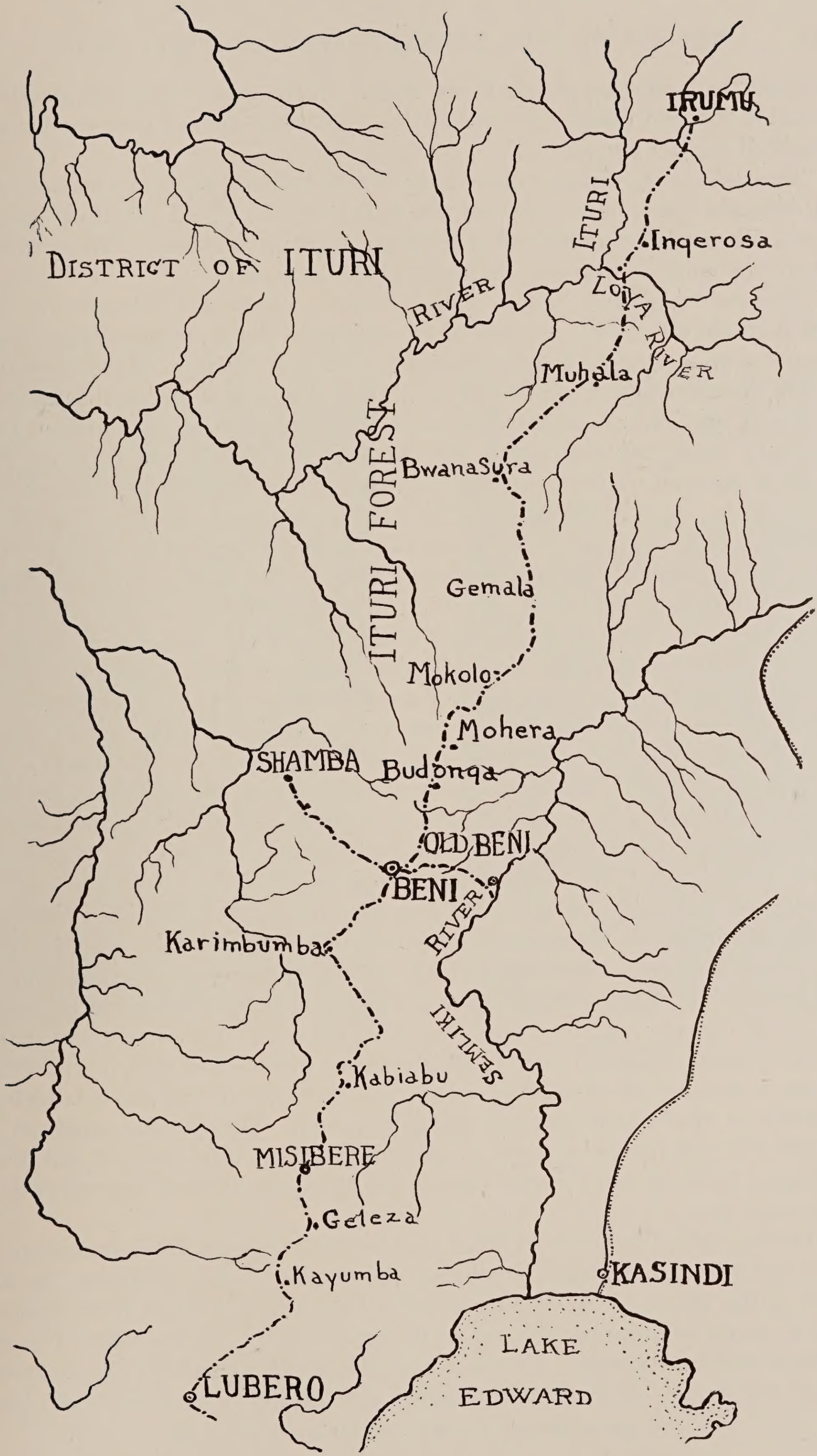

10
20
30
40
LAKE EDWARD
916 Meters
Contour
Talia River
LUOFU
Campi
Siku Moja
Lulema River
Kasoso
Ishasha River
Kwaka-Niki
Kwa-Ka-Tana
Kabare
Kagansa River
Village
2,000 Meters
Ruindi River
Ford
Contour
Kabasha
Kabasha Chini
Kalimbo
Village
Ishasha River
Kasoso River
Bridge
Ruchuru River
Village
Bara-Bara
Bilama
Escarpment
Iwi River
Village
Maji-na-Iwi
Hills
Maji-na-Moto
Fresh Water
Boundary of Uganda
UGANDA
Kayumba
Village
1°0'
2,000 Meters
Maji-na-Kwenda
Kwenda River
Line of Hills
Bridge
Pumbi
RUCHURU
Contour
Ruchuru River
Lake Mutanda
R
Scale 1 inch to 3.95 miles
1
5
10
15
Miles
0
5
10
15
20
25
Kilometers

⊙ Town. ● Native village. + Sites of our Camps.

----- Trails traversed by Safari. R Rest House.

Map No. V. — Route followed in Eastern Africa south of Lake Edward

(Prepared by Dr. G. C. Shattuck)


DISTRICT OF ITURI
IRUMU
ITURI RIVER
Inqerosa
LOYA RIVER
Muhala
ITURI FOREST
BwanaSura
Gemala
Mokolo
Mohera
SHAMBA
Budonqa
OLD BENI
BENI
Karimbumba
SEMLIKI RIVER
Kabiabu
MISIBERE
Geleza
Kayumba
KASINDI
LAKE EDWARD
LUBERO

Map No. VI. — Route northward in the Belgian Congo from Lubero to Irumu

One case had enlarged glands in the neck. In the other cases, the glands were palpable but very small. Several of these prisoners were in poor condition and appeared slightly somnolent.

In a case at the dispensary near the White Father's Mission where the sleeping sickness cases of the district are collected, the gland puncture specimen which we examined contained exceedingly few trypanosomes. There were but twenty patients undergoing treatment at the lazaretto.

The entire Semliki Valley between Lakes Albert and Edward, we found, had been almost entirely evacuated on account of the previous ravages of sleeping sickness, though the Belgian officials told us that certain wild tribes continued to live there in small bands in spite of all their efforts to evacuate the population. It is said that during the last few years the population of the southern half of this very fertile valley has been decimated by the disease. Most of the recent cases of sleeping sickness coming from this region have been collected in the lazaretto in the neighborhood of New Beni, referred to above. The Belgian officials believed that most of the cases of trypanosomiasis treated at New Beni occurred in persons who had previously lived in the Semliki Valley. Trypanosomiasis was certainly not developing to any great extent at New Beni, as far as is known, and could be ascertained at the time of our visit, though it has been feared that the disease may gain a footing in spite of the altitude.

We examined a few cases in the Semliki Valley itself that were suspected of being infected but found no trypanosomes. Also, we were surprised at the relatively very few tsetse flies observed in this locality. In the Semliki Valley as well as in the Ituri Forest, the only tsetse flies that we collected were on the elephants or buffalo we recently shot. Such game and wart hogs were plentiful. Hippopotomuses were also observed in the Semliki River, but no crocodiles were seen. (For routes followed see Maps V and VI.)

The epidemiology of sleeping sickness was investigated recently by the League of Nations Sleeping Sickness Commission, particularly in the Semliki Valley, the Upper Uele and in Budama and Kavirondo. They concluded that regarding the Upper Uele District as a whole it was apparent that the efforts of the medical service during the last three years had been crowned with success and that the disease was abating. However, they regard the endemic area in the Semliki Valley as serious,[1] the virus showing a tendency to spread and create fresh foci of infection in the *Glossina palpalis* distribution area. They further point out that in this area the natives possess no safeguard against infection but will, on the contrary, be the first to spread the disease by reason of their migratory habits and racial ties.

During 1927 Doctors Van Hoof and Lavier journeyed from Irumu to New Beni and through the lower portion of the Semliki Valley, following the lower spurs of the Mitumba Mountains as far as Lake Edward. Van Hoof points out that it would be quite possible for an unsuspecting traveller to follow this route without noticing *Glossina,* but that nevertheless *G. palpalis* exists everywhere on all the rivers. A number of *Glossina* that he found were dissected, but no

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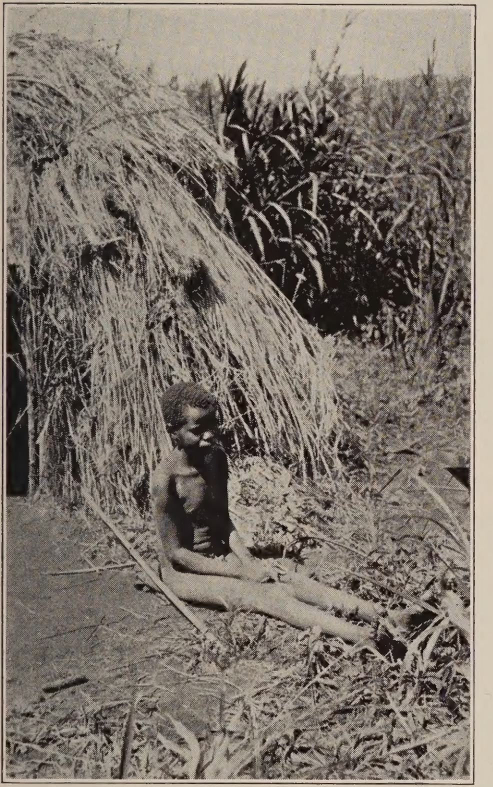
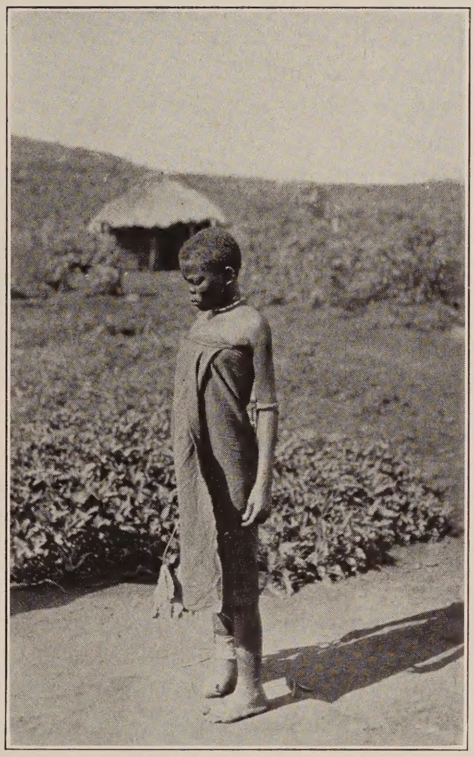
[1] See particularly Van Hoof and Lavier, *loc. cit.*, p. 329.



No. 318. — Sleeping sickness, Case 701, at Beni



No. 319. — Sleeping sickness and leprosy, Case 700, at Beni

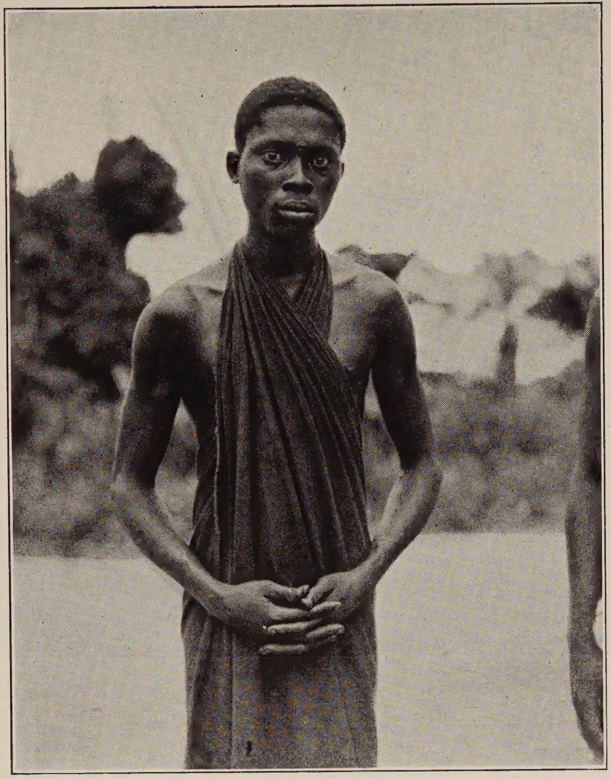
flagellates were found in them. He illustrates in a table the number of cases of the disease which were diagnosed in 1927 in these regions; eighteen of these cases were in New Beni, five on the road between Irumu and Beni, and four at the old Beni Mission. During the entire tour sixty-seven cases of the disease were diagnosed.

Prophylaxis and Treatment. In none of the areas, including the Semliki Valley, in which we travelled, did it seem to us that the abandonment of villages and evacuation of the inhabitants is now, with our present knowledge of prophylaxis, the most advisable procedure in the prevention of the spread of the disease. In the lower fertile and beautiful Semliki Valley near Old Beni, we found the guava, banana, and other plantations overrun and destroyed by elephants and buffalo, the houses of the old settlements in ruins, the clearings fast being overgrown by low brush and other vegetation, and the conditions becoming once more most favorable not only for wild game but for the development of tsetse flies. Since one is able by inoculation of several preparations [tryparsamide, germanine (Bayer 205) (Fourneau 309) and even atoxyl] usually to cause the trypanosomes to disappear from the peripheral circulation of the patient, it would appear that a more conservative and efficient method of control would be to concentrate upon the early diagnosis and treatment of the cases in the districts and to allow the population to remain in such districts; but, nevertheless, to insist upon the gradual clearing of the jungle by them and cultivation of the land in the infected regions. It has been argued that the destruction of the wild game may cause the fly to feed more frequently on man, but in the clearing of the land the gradual disappearance of the tsetse fly will occur as well as of the wild game that perhaps may act as a reservoir for the trypanosomes. Of course such measures require the maintenance of an organized staff of sufficient size successfully to prosecute the campaign.

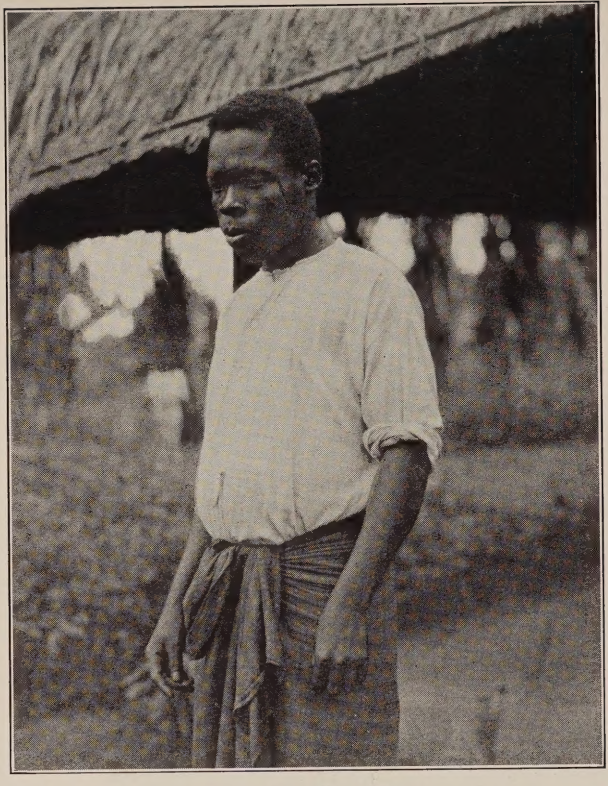
Drugs which have proved to be of great value in the treatment of sleeping sickness, unless the disease is well advanced, are tryparsamide, and Bayer 205 or Fourneau 309. At the present time a number of Belgian physicians in the Congo believe that Bayer 205 or Fourneau 309 cause a rapid disappearance of the trypanosomes in the acute stages of the disease, but these preparations are regarded as not so valuable in the advanced cases of trypanosomiasis as is tryparsamide. Maclean [1] has also recently called attention to the superiority of these preparations over others in the treatment of human cases. Louise Pearce [2] who first introduced in Africa the treatment with tryparsamide of human trypanosomiasis, has reported upon the favorable results obtained. With all preparations which contain organic arsenic there is, of course, danger to the optic nerve, and hence dosage should be carefully regulated. We saw several patients who, while they had been successfully treated for trypanosomiasis with tryparsamide, had become blind from the toxic effects of the drug, and the blind, uneducated African is, perhaps, better dead, for what has he left in life?

[1] Maclean: Ann. Trop. Med. and Parasit. (1929), XXIII, 337.

[2] Pearce: Science (1925), LXI, 90.



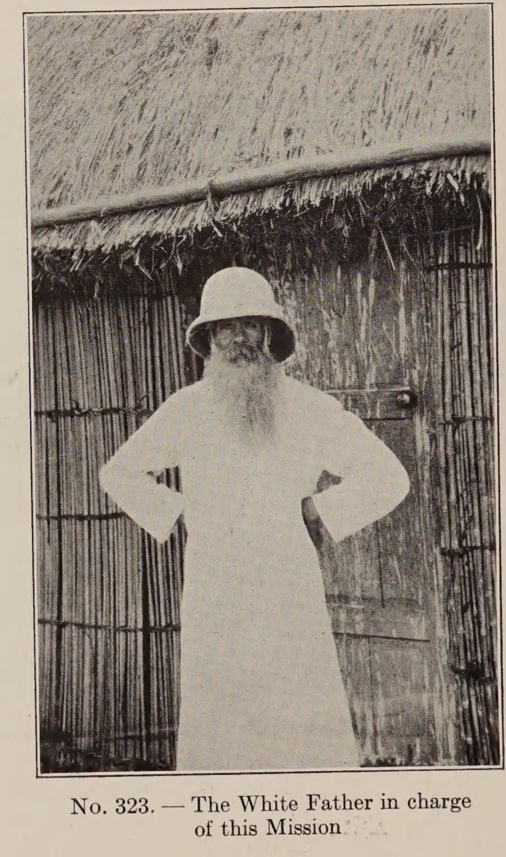
No. 320. — Case 595



No. 321. — Case 650

Convalescent sleeping sickness cases, blind as a result of treatment

No. 322. — Sleeping Sickness Mission on the edge of the Semliki Valley



No. 323. — The White Father in charge
of this Mission

XXVI

PLANT DISEASES

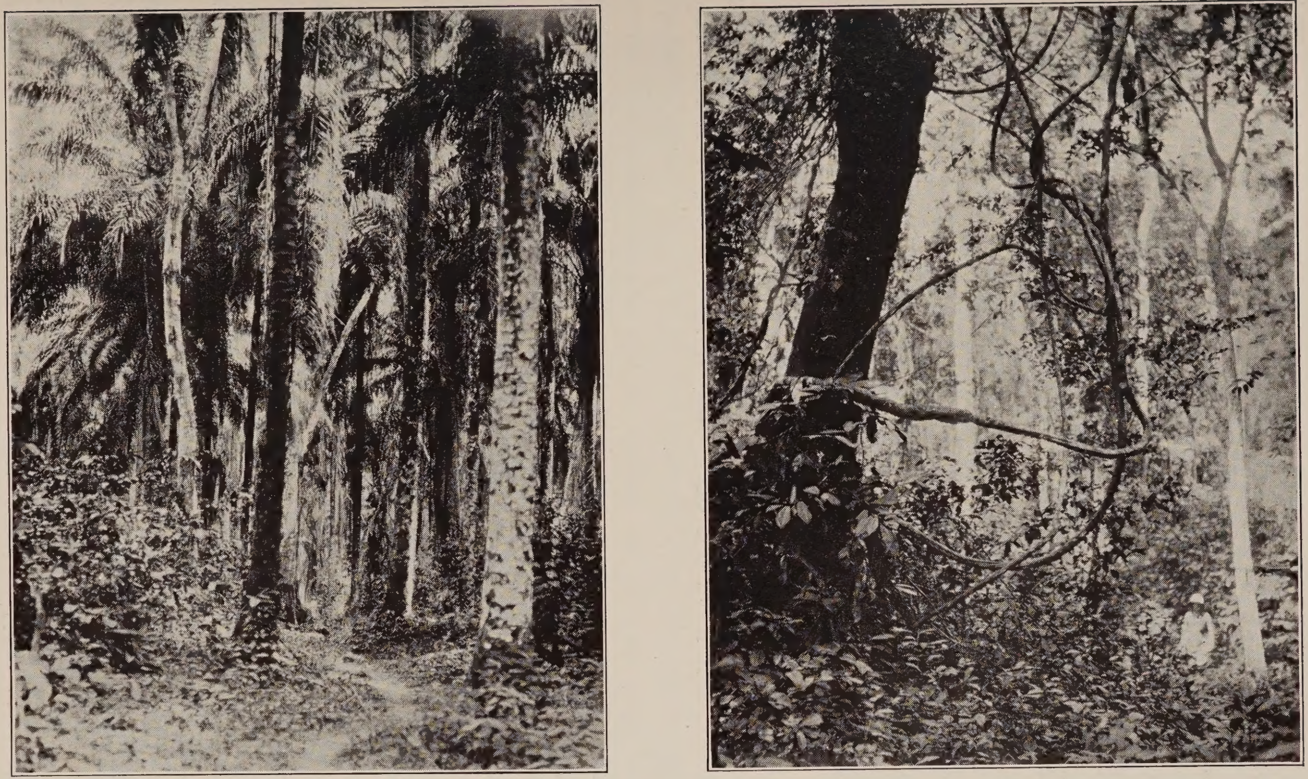
We did not discover any infectious diseases of the oil palm, *Elaeis guineensis*, or of the piassava palm, *Raphia vinifera* (Nos. 136, 333). Both of these palms are very common in Liberia and should be of great importance commercially.

The coconut palm, *Cocos nucifera*, is not indigenous to West Africa, having been imported probably in the early years of exploration of the West Coast. Only one large grove of coconut trees was observed near Monrovia and more scattered trees were found in the vicinity of a number of towns along the seacoast of Liberia.

Coconut disease. On visiting the grove of coconut trees outside of Monrovia several of the trees were found to be diseased, and on examining microscopically minute sections of the trunks in which necrotic areas were present, large numbers of nematodes were found (No. 336). The idea then naturally suggested itself that the disease was identical with or allied to that known as "red ring" or "Trinidad root disease" in the West Indies and parts of Central America where we have previously studied the condition. However, the macroscopical lesions of the affection in the African coconut were not as well defined as those of the Central American disease in which a well-marked ring of necrosis is usually noted in the trunk several centimeters beneath the periphery. Nevertheless, the gross appearance of the diseased trees was generally similar to that observed in "red ring" in that there was drooping and yellowing of the older fronds and beginning change in color in the younger ones. Dr. Linder, the botanist of the Expedition, who was also familiar with the red ring of South America, considered after examining the trees that the African affection was probably identical with the South American one (see page 522).

One tree, illustrated in No. 335, was later chopped down and sections of the tree from near the top were made and studied. No distinct red ring of pathological tissue was here seen, but the cross sections of the trunk and petioles showed a pinkish tint. However, even in red ring, particularly in early infections, the characteristic ring of diseased red tissue, 3 to 5 cm. from the cortex, often does not extend so high up the trunk. When fragments of this tissue taken from the trunk at least 15 to 20 feet above the surface of the ground were placed in water and observed under the microscope, very numerous motile nematodes were observed to have been set free. The note made at the time of the examination of different specimens of these nematodes with a higher power of the microscope states that some of the larvae were rhabditiform in structure, and rough drawings were made of them at the time. Portions of the tissue, together with the parasites, were preserved in formalin for further study.

Nos. 324–327. — The fertile but deserted Semliki Valley



Nos. 328, 329. — Forest near Alberta

Palm oil plantations of Lever Brothers where medical examinations were made

In typical red ring which we have observed in Spanish Honduras and Panama, the diseased trees usually show a progressive yellowing and browning of the leaves, commencing at the tips, the nuts being shed slightly in advance of the discoloration of the leaves and in a green condition. This may be the first external evidence of the infection. On section the stem shows a well-marked, complete ring of reddish-brown tissue, usually from 2.5 to 4 cm. in width and about 2.5 to 5 cm. from the periphery of the stalk. The diseased tissue may extend up the stem several feet and then become broken into longitudinal streaks and irregular small patches. The leaf stalks may also show these same pathological conditions. The roots become affected in the cortex, first undergoing yellowish or pinkish discoloration and softening, later becoming brownish-red and sometimes dry and flaky.

Cobb, in 1919, discovered a nematode *Aphelenchus cocophilus* to which he ascribed the cause of this red ring. In our studies in Central America [1] we confirmed the presence of this parasite which occurs abundantly in the roots in the areas where the tissues are softened. The parasite undergoes its complete life-cycle in the diseased tissues where the eggs are also deposited. The larvae which hatch from the eggs then invade the more healthy tissue. Larvae were found not only in the roots but also in different parts of the trunk and throughout the diseased tissues. While the habits of these nematodes outside the host plant have not been thoroughly studied, it seems reasonable to suppose that on the falling of diseased leaves or trunks the nematodes would ultimately find their way to the surface of the soil and subjacent layers, and that infection of the young plants might take place by the migration of the nematodes from the soil to the new plant. It has been shown that the nematode will live for a considerable time in the soil about an infected palm.

Experiments upon the Central American infection were conducted by Nowell [2] and Cobb [3] in which portions of diseased tissue containing these nematodes were inserted into healthy palms. Typical disease conditions were produced in this manner.

More recently Zetek [4] has suggested that the termite, *Coptotermes niger* (Snyder), may be a mechanical carrier of this nematode from the old host to the new plant, he having demonstrated nematodes clinging to the bodies of the termites which were living in a coconut palm infected with red ring. However, while infection may sometimes be transmitted through the agency of termites, they do not serve as the agent of transmissal in all cases since in many coconut palms infected with red ring no infestation with termites is present.

Further examination after our return to the United States, of the nematodes which we had obtained from the coconut disease of Africa, revealed the fact that they did not belong to the genus *Aphelenchus*. The photomicrograph of a male specimen (No. 336), conclusively demonstrates this fact. The material

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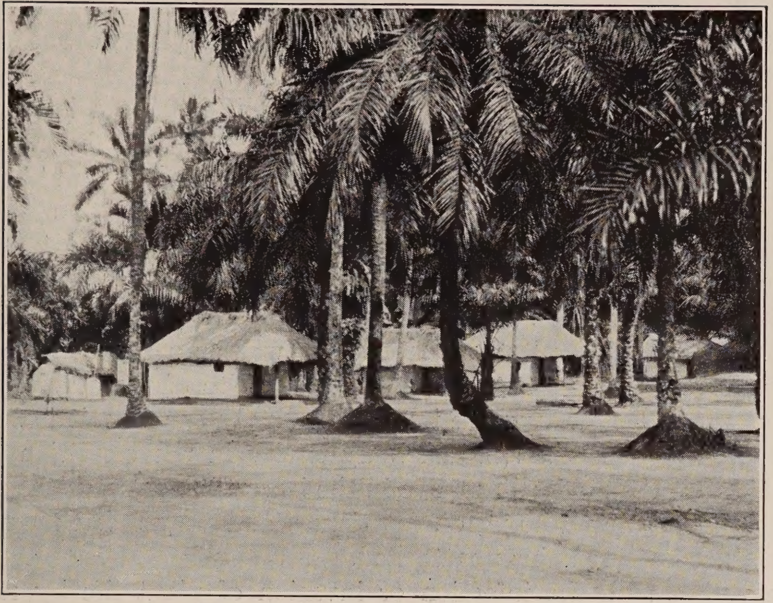
[1] Strong: "International Conference on Health Problems in Tropical America," United Fruit Co. (1924), p. 917.

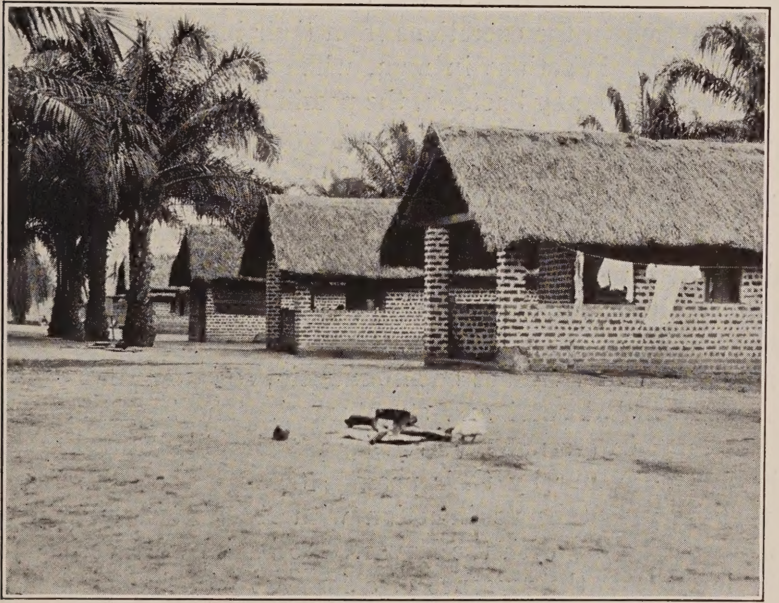
[2] Nowell: West Indian Bull. (1919), XVII, 189.

[3] Cobb: West Indian Bull. (1919), XVII, 203.

[4] Zetek: U. S. Dep. Agriculture Bull. (1924), No. 1232.



No. 330. — Plantation village, old type



No. 331. — Modern village, sanitary type

Alberta, palm oil plantations of Lever Brothers where medical examinations were made was then submitted to Dr. Cobb who kindly consented to examine it. He reported that neither *Aphelenchus* nor *Tylenchus* was present but the nematodes consisted of two species of *Diplogaster*.

The genus *Diplogaster* Schultze (family Rhabditidae), is a large one comprising more than a score of known species. Many of these have been found in moist soil, in water, between the sheaths of grasses, etc. Rahm [1] has recently found species in banana, sugar cane, and mandioca. Cobb [2] considers that a number of species of *Diplogaster* appear to be at least facultative parasites. They have also been found in dead insects and caterpillars whose death they have apparently caused. Very recently Stekhoven [3] pointed out that some species of *Diplogaster* may lead a parasitic as well as a saprophytic life. He has shown that *Diplogaster entomophaga* is a parasite of the staphilinid beetle *Astilbus* and may apparently cause its death. In the examination of the nematodes extracted from the abdominal body cavity in the condition described, he concluded that the nematodes move in the interstices between the abdominal musculature, apparently feeding on fat tissues and very soft tissues, whereas the musculature itself remains unattacked.

In connection with the infection or invasion of plant life by nematodes, we should like to emphasize that such nematodes entering from the soil, or even those introduced or transmitted by insects, may sometimes offer an opportunity for the introduction into the plant tissues of bacteria or the spores of fungi, which may be present either upon the external integument of the nematodes or perhaps in the excretions from their intestinal tract. In relation to certain nematodal infections in man, while the epidermis acts as a filter against the invasion of many bacteria, the possibility of the entrance of bacteria into the body through the passage of *Uncinaria* or *Strongyloides* from the surface of the skin into the circulation, is also a subject of some interest for further investigation.

When this Report was about to go to press, the interesting experiments of Kawanishi [4] were published. He has found that in percutaneous infection with *Ancylostoma* larvae, bacilli adhering to the larvae may be carried into the human body, and infections with these bacilli may result. On the surface of *Ancylostoma* larvae he found various bacilli, namely, *coli communis subtilis*, *pyocyaneus*, etc., also staphylococci and streptococci. The bacilli adhering to the surface of the larvae were not removed by washing in distilled water, nor by passage through agar, nor by their passage through the skin. He concludes therefore that in percutaneous infection with *Ancylostoma*, bacilli will enter the human body together with the larvae. No bacilli were verified within the body of the larvae but the presence of a ferment with bactericidal properties could be demonstrated in them.

Steiner [5] has recently reported experiments which suggest that the trans-

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[1] Rahm: Arch. do Inst. Biologico de defesa Agricola e Animal (1929), II, 67.

[2] Cobb: Ward and Whipple's "Fresh Water Biology" (1918), p. 488.

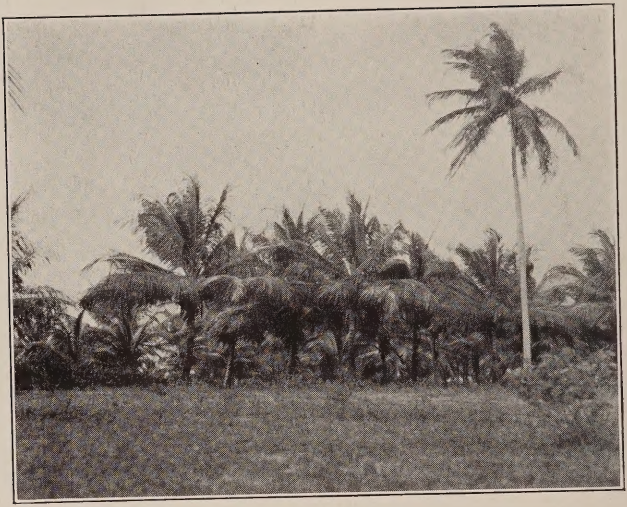
[3] Stekhoven: Zoologischer Anzeiger (1929), LXXXIII, 265.

[4] Kawanishi: Experimental Studies on the Entrance of Path. Bacilli incidental to Percutaneous Infection with Hookworm. 1929.

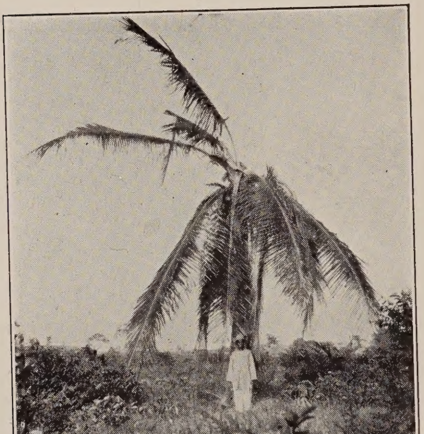
[5] Steiner: Jour. Parasit. (1928), XV, 71.

No. 332. — *Elaeis guineensis*, the oil palm, Liberia

No. 333. — Rattan palm, *Calamus*



No. 334. — Grove of coconut palms, *Cocos nucifera*, near Monrovia

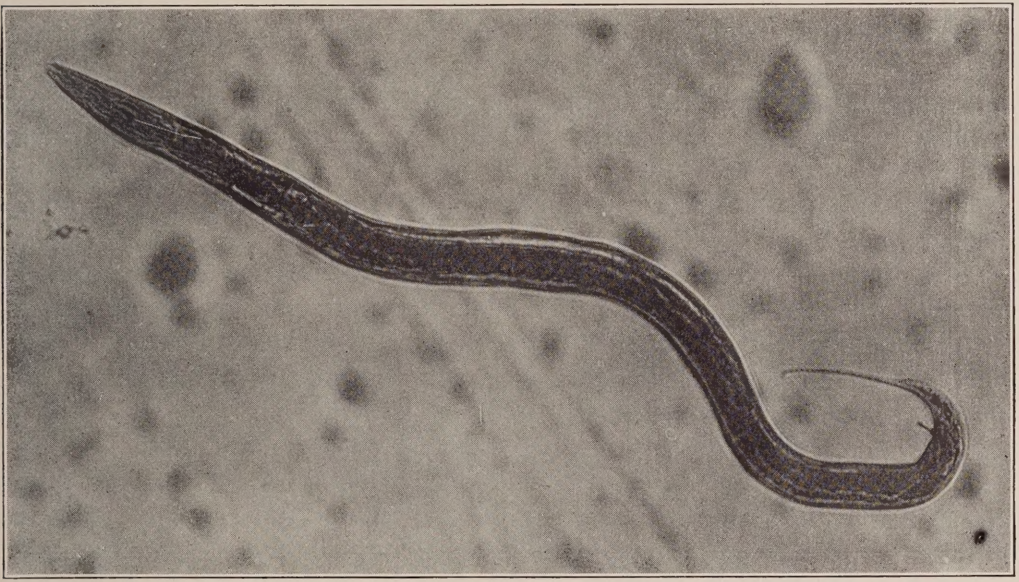


No. 335. — Diseased coconut palm

mission of one of the so-called virus diseases of plants may occur through the medium of plant parasitic nematodes.

Just how the lesions of red ring in the cocoanut are produced by *Aphelenchus* or how the similar disease in Africa may be caused by *Diplogaster*, or indeed how the other plant diseases result in which different species of *Aphelenchus* or *Tylenchus* have been encountered, is not at all clear. Cobb has pointed out that it is by means of a sharp onchus or spear lying in the pharynx and extruded from the buccal orifice that the invasion of the plant by some of these parasites is specially made possible.

In red ring, the lesions consisting of softening of the tissues, their liquefaction and subsequent necrosis are apparently not of a nature that one can reasonably attribute to nematodes alone. In no pathological condition of which we have knowledge are such necrotic lesions produced by parasitic worms.



No. 336. — *Diplogaster* sp. from *Cocos nucifera*

We have earlier called attention to the fact[1] that in "red ring" bacteria are very frequently associated with the nematodes in the lesions and have suggested that the bacteria, often probably introduced by the nematodes, may play an important part in the destruction of the tissue.

So far as we have been able to ascertain, nematode invasion or infection of *Cocos nucifera* has not been previously reported from Africa. We are not able to say whether the relative scarcity of coconut trees along the Liberian Coast is to some extent due to this disease. Linder, on page 522 has referred to the preventative measures to be taken regarding the spread of "red ring."

Mandioca mosaic. A disease of the mandioca plant (*Manihot palmata*) is very common throughout Liberia and parts of the Belgian Congo. We noticed the affection in Liberia shortly after we started into the interior. However, we have not noticed it previously in tropical countries where mandioca is common, as in Central or South America. Notwithstanding the fact that it is so common in parts of Africa, we have found no written description of it and nothing seems to be known of its etiology. The Acting Director of the Botanical Gardens at Coquilhatville in the Belgian Congo, to whom we spoke later of the affection, said that while he had of course observed it, its cause was quite unknown.

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[1] Strong: Relation of Certain "Free Living" Saprophytic Microorganisms to Disease. Science (1925), LXI, 97.

In the affected plants, many of the leaves are deformed, distorted, curled and shrivelled, and frequently have a wilted appearance, while some of the plants are very much stunted. Often there are irregular areas in the leaves which are of a less dark green or of a yellow color in which there is evidently a marked loss of the chlorophyl (Nos. 338–340). The condition of the leaves suggested a form of mosaic disease or infectious chlorosis, and that it was apparently not a form of heredity or of malnutrition chlorosis. However, it seems possible that the condition described under the term "mosaic disease" may represent a group of infections or at least more than one type of infection, and that the term mosaic disease has sometimes been applied more to a symptomatic condition.

One of the first mosaic diseases discovered, that of the tobacco plant, is generally regarded as being due to a filterable virus, Ivanoski [1] being the first one to show that the affection could be transmitted by the filtered juice of the plants. Olitsky [2] reported he had cultivated this virus or at least he was able to show that the active agent remained alive in sterile juices of the plant for thirty-three days and that transfer of it could be made from tube to tube. However, Goldsworthy,[3] Mulvania,[4] and Purdy [5] have been unable to confirm Olitsky's work upon cultivation. Up to the present time no plant virus has been proved to multiply except when associated with living plant cells.

Recently Murphy [6] has pointed out that the virus diseases of plants give the impression of being a more homogenous group than animal virus diseases. He emphasizes that while it is easy to filter the sap of the plant and to obtain a filtrate free from any visible life, in numerous diseases of plants, presumed to be virus diseases, it is not possible by mechanical processes to infect the plant with the filtrate. On the other hand, virus diseases can be transmitted from plant to plant by grafting or pruning different plants, and this is looked upon as the hall mark of virus disease in plants. He also points out that a characteristic of virus diseases of plants is the fact that they are systemic and affect all the plant tissues, leaves, stem, root, everything except the seed, which, among plant diseases in general, is very unusual. He suggests that the agent producing these virus diseases is entirely distinct from the fungi, bacteria, and

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[1] Ivanoski: Cent. Bac. (1893) Botan. Beihft. 3.

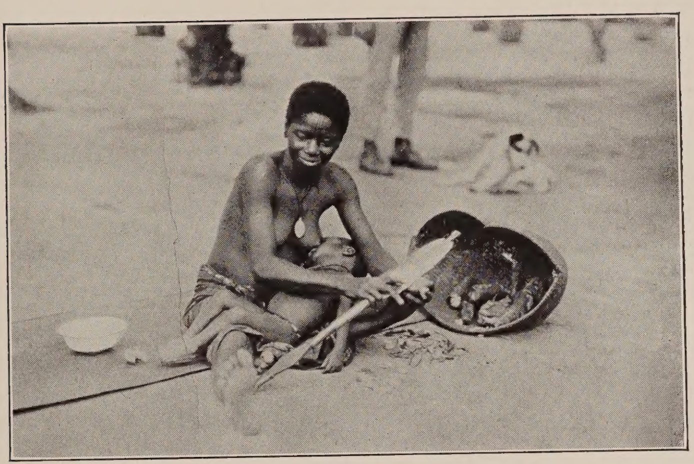
[2] Olitsky: Jour. Exp. Med. (1925), XLI, 129.

[3] Goldsworthy: Phytopathology (1926), XVI, 873.

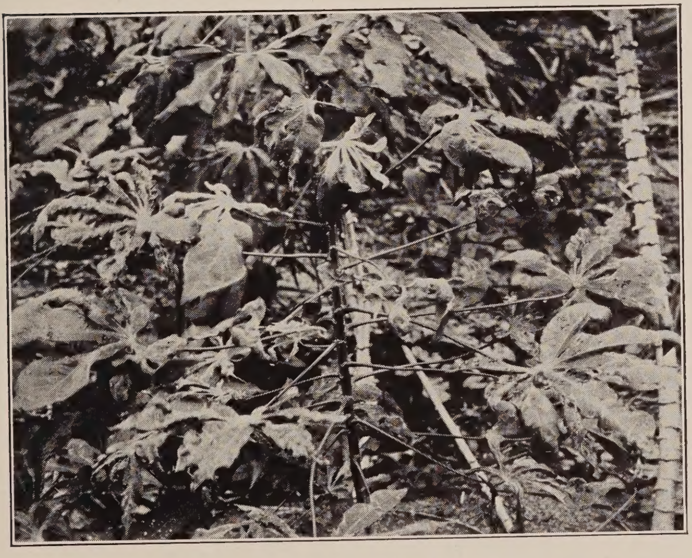
[4] Mulvania: Science (1925), LXII, 37.

[5] Purdy: Bot. Gaz. (1926), LXXXI, 210.

[6] Murphy: Proc. Royal Soc., Feb. 28, 1929; published in Brit. Med. Jour. (March 9, 1929), p. 448.



No. 337. — Preparation of mandioca, *Manihot palmata* root, for food



No. 338. — Mosaic in *Manihot palmata*

protozoa which produce other diseases in plants. Keeping these definitions in mind, further experimental work including transmission of the disease by filtered juices apparently will be necessary before the African mandioca disease to which we are referring can be definitely included in the mosaic or virus diseases of plants.

A number of workers have described amoeba-like bodies in the cells of tobacco plants with mosaic, and recently plasma-like bodies have been found in the cells of plants affected by several virus diseases. McKinley,[1] in his admirable monograph upon the general subject of filterable virus diseases, has reviewed very completely this work, and has discussed the different, bacterial, enzyme, filterable virus, and protozoan theories in connection with the etiology of mosaic diseases. He believes that there is abundant evidence to support the filterable virus theory, to which view most investigators are inclined.

Purdy [2] has recently given some evidence in favor of the infectious nature of these diseases. She has shown by immunologic reactions with tobacco mosaic virus, injected intravenously into rabbits, that there is some evidence that a specific antibody to tobacco mosaic virus-sap, lytic in nature, is present in the homologous antiserum.

In Liberia and the Belgian Congo we made a microscopical study of the different parts of the diseased mandioca plants, the roots, stalk, and leaves. We were unable to find any animal parasites present and no forms resembling amoeboid protozoa were seen. However, in the latex of the main stalk and of the stem at the base of the leaves of a number of diseased plants, both rounded uniformly-staining cells from about 2 to 4μ in diameter, suggesting forms of a fungus, and smaller, slender bacillary bodies up to about 2μ in length, have been found in some plants in considerable numbers. After studying for some time and finding these small bacillary bodies in preparations of the latex of diseased plants only (and not in the latex of healthy ones), they were finally found in small numbers in healthy plants; therefore the presence of the bacillary bodies seemed of much less significance. However, it should be mentioned that these apparently healthy plants were growing in the same region with diseased ones, since it has been pointed out by East, Weston [3] Allard, and other investigators that in sugar cane and tobacco mosaic, the plants may nevertheless harbor the virus and be infective although they are apparently healthy. In other words, the infection may be dormant within them. Murphy has also pointed out that unlike animals infected with virus diseases the majority of plants infected are "carriers."

Cultures were made from the latex of a number of diseased plants after a thorough burning of the surface of the stalks. No growths of bacteria or of the bacillary bodies were obtained, but cultures of a fungus were obtained on two different occasions in which the colonies always showed a reddish-brown tinge. A further investigation was to have been made of this fungus, but after our return

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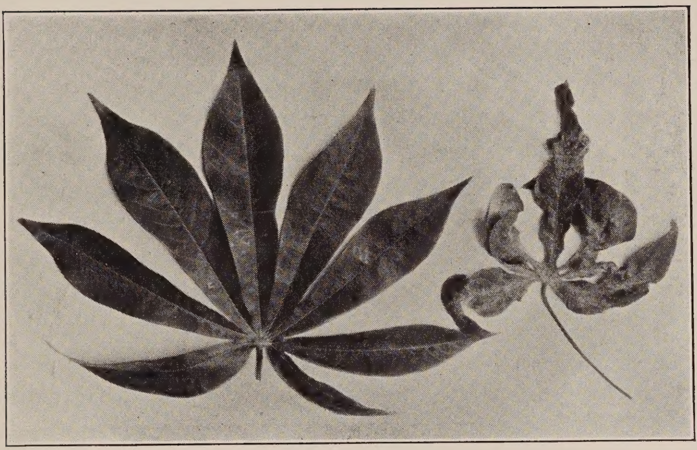
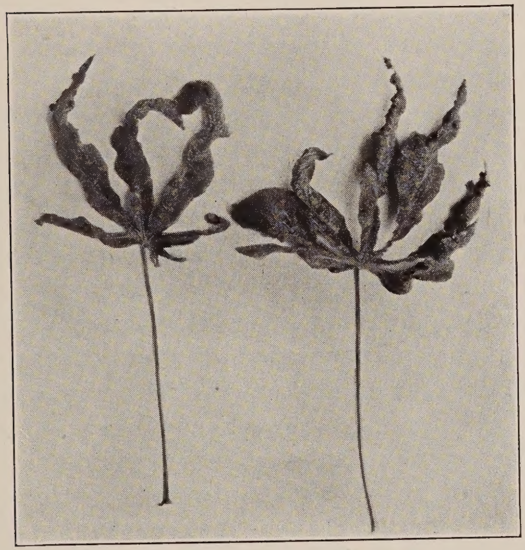
[1] McKinley: Phil. Jour. Science (1929), XXXIX, 344.

[2] Purdy: Jour. Exper. Med. (1929), XLIX, 919.

[3] East and Weston: Contributions, Harvard Inst. Trop. Biol. and Med. (1925), p. 15.





Nos. 339, 340. — Healthy and diseased leaves (*Manihot palmata*) it could not be recovered from the culture which though previously sealed had become contaminated and overgrown with bacteria. Sections of many of the diseased plants, roots, stalk, and pieces of the leaves, were preserved in formalin and in Zenker's solution in Africa and sectioned after our return to this country. They have been stained by safranine, haematoxylin and eosin, Giemsa's solution, and Levaditi's stain. A histological study of sections of the tissues of the diseased plants does not reveal as large a number of bacillary bodies as we observed in fresh, unstained preparations. However, they are present in small numbers, staining, and decolorizing by Gram like delicate bacilli or rickettsia. In the sections of several of the diseased plants, larger rounded bodies are also present which are evidently the spores of fungi. While usually they are circular in outline, measuring from 2.4μ to 4.5μ in diameter, occasionally a dividing form roughly dumb-bell in shape is seen. The stem of two of the plants is richly infected with the fungus and one or two of the micro-organisms are present in many of the cells. Occasionally there is a group of them within a single cell. They, however, have not yet been found in the cells of the terminal leaves. In addition to these conditions, one finds in some areas that the cytoplasm of the cells is vacuolated, in others that the chloroblasts in large areas show distinct loss of pigment. No protozoa have been discovered in the sections.

Kunkel,[1] Goldstein,[2] Rawlins and Johnson,[3] Smith [4] and Hoggan [5] have all reported intracellular bodies said to resemble more or less the Negri bodies of rabies, or the Guarnieri bodies of variola in corn, tobacco, sugar cane, Chinese cabbage, and Hippeastrum mosaic. It has been suggested that these intracellular bodies might have some etiological significance. Nothing suggesting Negri bodies could be found in the sections of our African mandioca. The recent work of Holmes [6] with excellent photomicrographs seems to support the idea that these intracellular bodies which have been found in mosaic are not of a parasitic nature, since no definite nucleus can be demonstrated in them. Some of his photomicrographs show dot-like and apparently short bacillary forms of chrondriosomes in the intracellular bodies, and Holmes considers this to be evidence for the view that the intracellular body in Hippeastrum mosaic consists of living cytoplasm. In addition to these intensely staining bodies he also found spheres containing deep-staining peripheral single or, rarely, double balls. These spheres were very definitely formed and easy to recognize. They were found in the cell cytoplasm in diseased plants but not in that of healthy plants. He further remarks that whether the intracellular body represents a stage of a foreign organism, a mass of plant cell cytoplasm containing virus, or a mass of plant cell cytoplasm not immediately in contact with the virus but stimulated by the disease condition is not known. Elsewhere he points out that the dot and short bacillary forms could not be distinguished by Giemsa's stain, although they took other dyes intensively.

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[1] Kunkel: Science (1922), LV, 73.

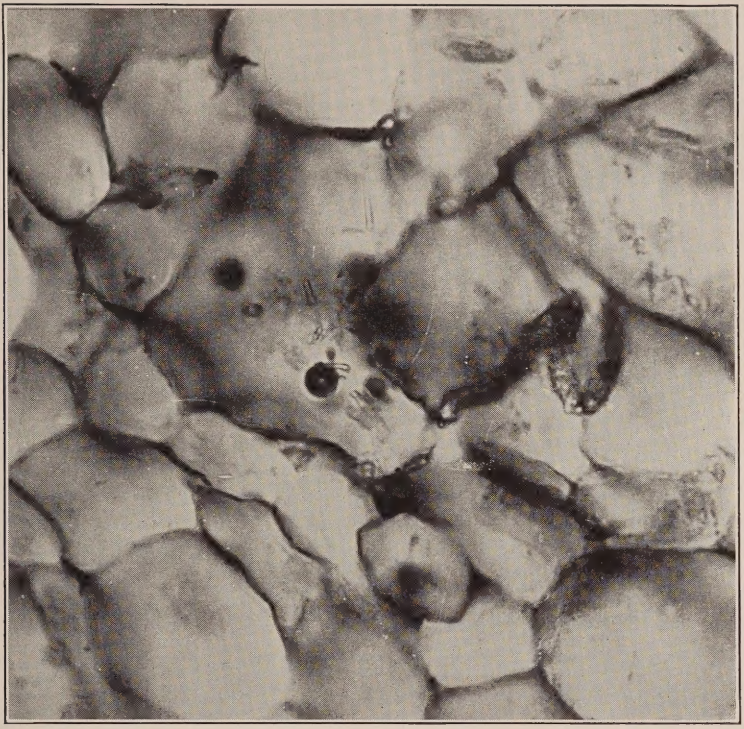
[2] Goldstein: Bull. Torr. Bot. (1924), LI, 261.

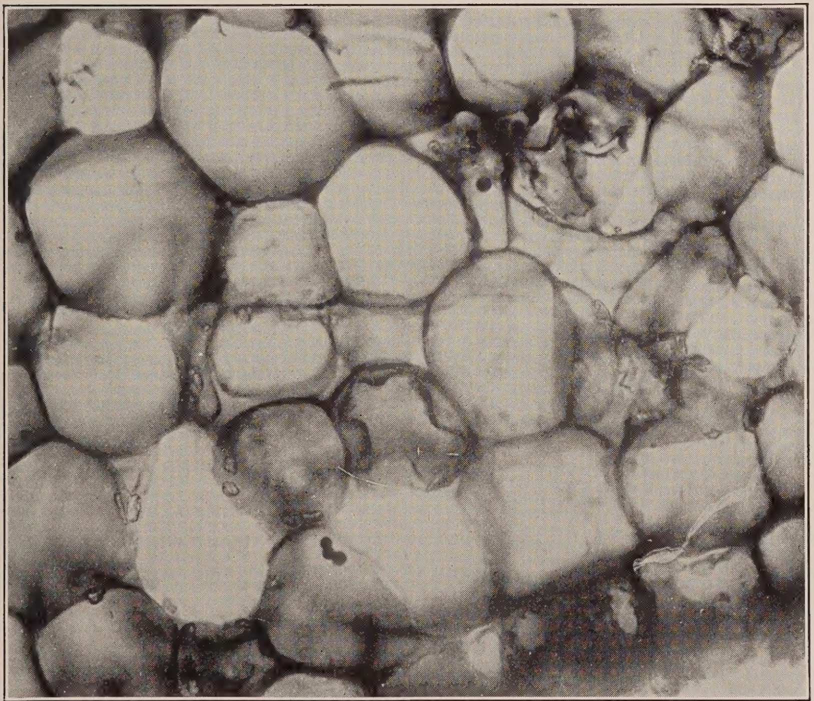
[3] Rawlins and Johnson: Amer. Jour. Bot. (1925), XII, 19.

[4] Smith: Ann. Mo. Bot. Garden (1926), XIII, 425.

[5] Hoggan: Jour. Agr. Research (1927), XXXV, 651.

[6] Holmes: Bot. Gaz. (1928), LXXXVI, 50.





Nos. 341, 342. — Photomicrographs of diseased mandioca revealing fungus infection

In a subsequent paper [1] he describes the preparation of ultraviolet light photographs of seven typical juices of plants infected with virus diseases, using a wave length 275 millimicrons, but no formed structures other than those seen in corresponding fluids in healthy plants were found.

Jones [2] had previously reported the cultivation of a mycetozoon which he named *Plasmodiophora tabaci* from tobacco juices affected with mosaic disease. He further found that identical symptoms were produced following the inoculation of healthy tobacco plants with such cultures. He was able to find the plasmodial stage of the protozoan in tissues of tobacco plants displaying similar symptoms of the disease, but healthy plants were entirely free of it.

However, the more recent investigations of Link and Taliaferro,[3] in which Jones also collaborated, seem definitely to show that *Plasmodiophora tabaci* can be cultivated from both healthy plants and those affected with mosaic, provided they are not washed in an antiseptic solution such as mercuric chloride and that the inoculation of tobacco plants with cultures containing various stages of *P. tabaci* is followed by mosaic only when the cultures are derived from diseased plants in which case a concomitant mosaic virus could be present and carried by pollution. They also show that filtrates from diseased plants which were infective for healthy plants did not show any *P. tabaci.*

In view of the large amount of evidence that the causative agent of a number of the mosaic viruses pass through diatomaceous and porcelain filters, it seems evident that the infective organism must consist of a very minute stage. It has been pointed out that the intracellular bodies referred to could hardly be of etiological significance since they are too large to pass through the pores of a porcelain filter. However, the infective units or spores of which they are composed may be very minute. The recent work of Link [4] and of Holmes [5] all emphasize this fact.

The results of our histological study of the African mandioca disease are different obviously, from some of those which have been referred to in connection with the mosaic disease of tobacco. The chromatinic dot and rod-shaped bodies that we have found, while they resemble somewhat those observed by Holmes in Hippeastrum mosaic, stain differently from the chondriosomes. They resemble also in form the mitochondria which Cowdry and Scott [6] have recently found to be present and illustrated in *Plasmodium kochi* and *Plasmodium praecox,* through supravital staining with Janus green. The nature of the round and rod-shaped bodies in our sections is not entirely clear. One cannot conclude from their appearance that they are bacteria, nor can one assume that they are connected with the cells of the fungi near which they often lie, nor that they are the spores of the fungus. It seems possible that they may represent degenerative products but their presence in such small numbers would appear to argue against

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[1] Holmes: Bot. Gaz. (1928), LXXXVI, 59.

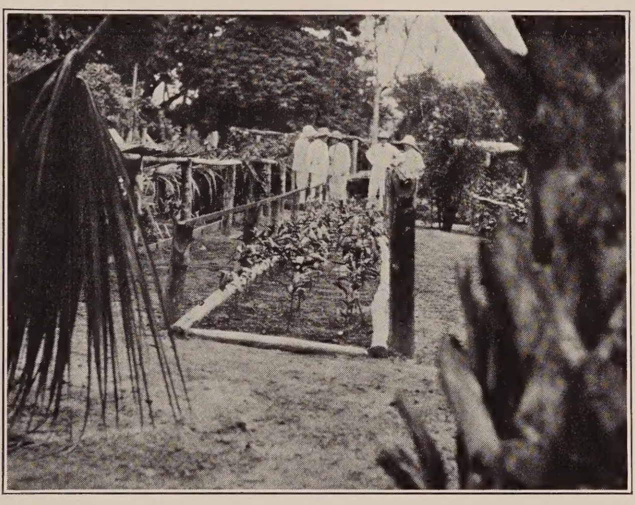
[2] Jones: Bot. Gaz. (1926), LXXXI, 446.

[3] Link and Taliaferro: Bot. Gaz. (1926), LXXXII, 403.

[4] Link: *Loc. cit.*

[5] Holmes: Bot. Gaz. (1928), LXXXVI, 66.

[6] Cowdry and Scott: Arch. Inst. Pasteur de Tunis (1928), XVII, 233.



No. 343. — Cultivation of *Hydnocarpus* plants, Botanical Garden, Eala, Congo (for treatment of leprosy)

No. 344. — Diseased and healthy quinine plants (*Cinchona succirubra* plants), Eala, Congo

this last hypothesis. Cowdry[1] in his study of the microchemistry of the nuclear and cellular inclusions in virus diseases, points out that these are occasionally feebly basophilic, but that the majority are strongly acidophilic (or oxyphilic). We found nothing to suggest the intracellular bodies of Holmes and other authors, but, on the other hand, we did find, on several occasions, a fungus infection in the latex.

It must be admitted that the spores of fungi which are present in the tissues of several of the plants affected with the African mandioca disease, are somewhat similar in appearance to the inclusion bodies of Hippeastrum mosaic, of wheat rosette, and of the Fiji disease, as illustrated by Kunkel[2] in his recent article on the Virus Diseases of Plants. They resemble more the inclusion bodies of Hippeastrum mosaic, since an appearance somewhat resembling budding may be observed in Kunkel's illustration. However, in the sections of the African mandioca disease they can be definitely identified as elements of a fungus, which is not the case in Kunkel's sections.

While it seems probable that this extensive fungus infection of the latex of two of the mandioca plants examined must play some rôle in the pathological condition encountered, it is also realized that since the fungus infection was not demonstrated in the majority of the diseased plants, it probably is merely a secondary invader which has been imposed upon a primary virus infection.

Obviously, the infection in Liberia should be carefully studied and inoculation experiments made, both with filtrates of the latex and with the fungus isolated. Such studies were impracticable for us to carry out on the present Expedition, especially from the standpoint of the time they would have consumed. Our object is particularly to call attention to the wide prevalence of the infection in Liberia and to the necessity for further studies regarding its etiology.

No observations suggesting insect transmission of this mandioca disease were made by us in Africa. *Aphis maidis* has been shown to transmit other forms of mosaic disease in various parts of the world. It, however, was not seen on any of the mandioca plants in Africa. In fact, the only arthropod observed on a few examples of diseased mandioca in Africa was a species of mite collected by Bequaert. Kenneth Smith[3] has pointed out that in the mosaic group of diseases it is fairly obvious that the insect is nothing more than a mechanical carrier, but that in certain other plant diseases the virus is spread only by one particular insect. Steiner[4] has reported experiments which at least suggest that the root-knot nematode *Caconema radicicola* Cobb (= *Heterodera radicicola*) is able to transmit tomato mosaic. Whether the transmission of the mandioca infection in Africa may occur (as elsewhere in other definite forms of mosaic disease) both through cuttings and through insect transmission will require further investigation.

We did not observe in Liberia, the disease of mandioca caused by Cecidomyiidae that we met with in Amazonia, particularly along the banks of the lower Rio Negro. The midges concerned in the production of this disease were identified and described by Felt and Bequaert [1] in the Amazon Report as *Cecidomyia manihot*. Other diseases affecting mandioca have been investigated by Rahm [2] who has recently found five species of nematodes invading the roots of this plant in Brazil. Since our investigations were made in Liberia, McKinney [3] has visited Monrovia and has observed mosaic disease there on cultivated egg plants, peppers, *Capsicum frutescens*, as well as on cassava.

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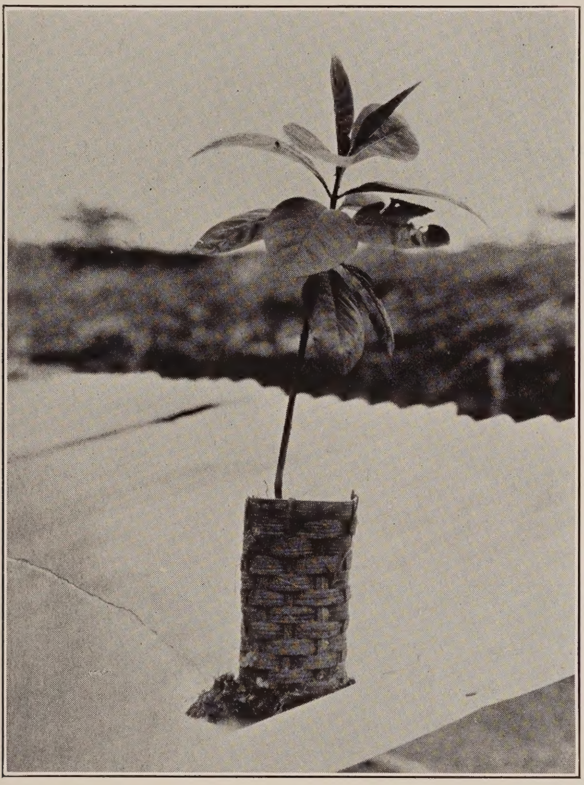
[1] Cowdry: Science (1928), LXVIII, 40.

[2] Kunkel: Filterable Viruses, edited by Thos. Rivers (1928), p. 364.

[3] Kenneth Smith: Brit. Med. Jour. (1929), Part I, p. 448.

[4] Steiner: *Loc. cit.*



No. 345. — Potted quinine plant ready for shipment, Eala

Cinchona infection. A disease of especial interest to students of tropical biology and medicine is one which affects the quinine plant, *Cinchona succirubra*. The Government botanical garden of Eala is situated near Coquilhatville on the Congo River. One of its purposes is to develop agriculture in the Congo and also to bring about acclimatization of foreign useful plants and cultivate them experimentally. Here cultivation of both chaulmoogra and *Hydnocarpus* plants (used for the treatment of leprosy) and of *Cinchona* plants, is carried on. The young plants are potted in baskets and sent from these nurseries to different parts of the Belgian Congo for planting and cultivation.

Among some of the beds of young *Cinchona succirubra* plants, from one to

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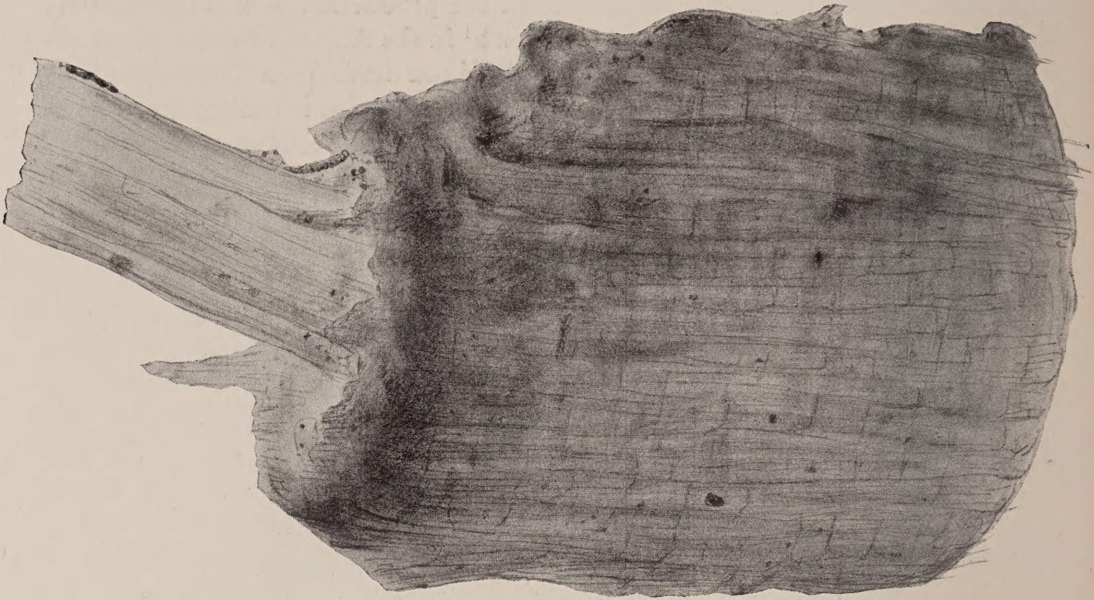
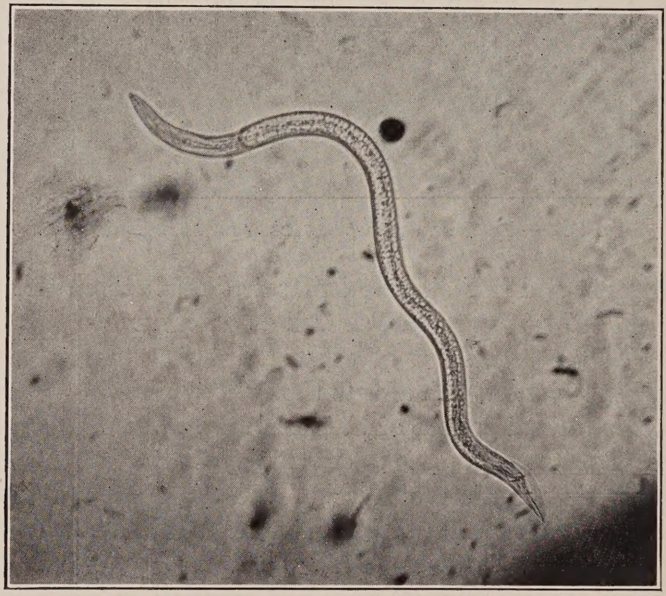
[1] Felt and Bequaert: Medical Report of the Rice 7th Exped. to the Amazon (1926), p. 204.

[2] Rahm: *Loc. cit.*, p. 107.

[3] McKinney: Jour. Agri. Research (1929), XXXIX, 557.



No. 346. — Drawing under microscope of root of diseased quinine plant (about 4x)

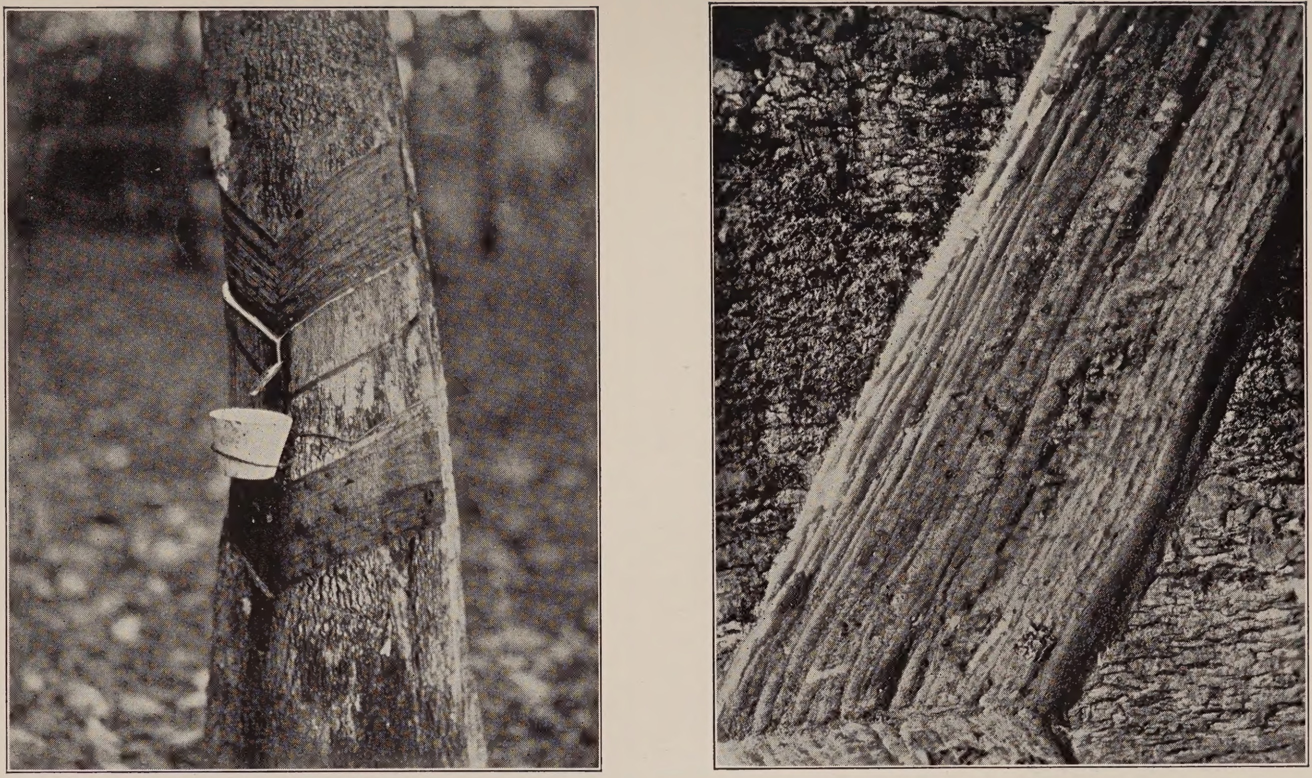


No. 347. — *Tylenchus alatus* n. species (Cobb 1930),
from diseased quinine plant

three feet high, we noticed many diseased ones with brown or wilted leaves and stalks, and through the kindness of the director, Dr. Corbisier, were able to secure a large number of the diseased and healthy plants for examination. From a comparative study of these it was possible to show that in the diseased plants the terminal roots were not of the normal gray color observed in the healthy ones, but were more or less of a dark brown color and showed in places numerous small areas where decortication of the bark had taken place (Number 346). Scrapings from the roots of the diseased plants revealed large numbers of larval forms and adults of the genus *Tylenchus* which are characterized by the buccal armature and the character of the oesophagus. Since our return to the United States these parasites have been kindly studied by Dr. Cobb who concluded that the parasite is a species new to science which he has described and named, as *Tylenchus alatus* (Number 347), this name being particularly applied on account of the broad, wing-like expansion of the caudal extremity. Dr. Cobb has kindly consented to the publication of his description of this species which is given on page 487. The parasites were found in the *Cinchona* plants almost anywhere in the roots as far as the crown. The adults, male and female, were also found in smaller numbers upon and beneath the bark of the roots. In places where the decortication of the bark had taken place there was sometimes a secondary infection with a fungus growth, a few mycelial threads of which were visible on the surface but did not penetrate into the interior of the root. This parasite, as Cobb has pointed out, has a very well developed, long, typical tylenchoid spear. It is apparently by this structure that it is enabled to pierce the bark of the roots and, being very active and muscular the worm is able to work its way between the covering of the root and the central core. This disease apparently has not previously been described in *Cinchona* plants. Quinine production in the Congo is clearly a matter of considerable importance as the Belgian Government here alone uses some thousand kilos annually. In Liberia *Cinchona* has not as yet been cultivated.

Infection of rubber trees. Rubber cultivation is evidently of very great importance in Liberia, particularly in connection with the extensive activities of the Firestone Plantations Company. However, we did not find any serious disease of the rubber trees there. In fact, the only infection noted was the growth of a fungus which occurs in black lines along the trunk of the trees (*Hevea brasiliensis*) where they have been denuded of bark in collecting latex. This fungus was identified by our botanist, Dr. Linder, as *Phytophthora meadii* (Petch). Linder, in describing this disease, points out that the first symptom of the condition is the cracking in vertical lines of the cortex that remains after the outer layer is removed in tapping. Around the cracked lines there is a depressed area underneath which the tissue is blackened. At the same time the cambium layer is killed to a depth of a quarter of an inch. With age, the blackening becomes evident externally, the lines elongating and tending to fuse, thus forming a darkened area with a ragged diffuse outline. In wet weather this blackened surface is covered with a white, cottony layer in which the zoosporangia of *Phytophthora* are produced. Linder has illustrated this condition and made original drawings of the fungus *Phytophthora meadii* (Petch), page 524. He also points out that in addition to *Phytophthora* there was present on the rubber trees, sometimes associated with this fungus, a species of *Fusarium* of which he found both the macro and microspores. He believes, however, that this latter fungus is secondary and may even lead a saphrophytic life in the latex remaining on the surface. However, in view of the parasitic nature of the genus, he believes the subject should be further investigated.

A large number of other plants and of trees were examined in Liberia for evidences of parasitic infection or other infectious diseases, but no results of importance were obtained.



Nos. 348, 349. — *Hevea brasiliensis* rubber trees illustrating fungus infection occurring in black lines and patches after removal of cortex and tapping

XXVII

ANIMAL PARASITIC INFECTIONS

It was a routine procedure during the Expedition to perform a necropsy upon all animals collected either for zoological purposes, or museum specimens, and upon all wild game shot for food. As a result a number of interesting parasitic infections were encountered, some of which have not previously been described. The following observations are based upon the necropsies performed and the subsequent study of material thus obtained.

Haematozoa

Monkeys, Cercopithecus, Colobus. A number of parasitic infections were observed in monkeys. Haematozoa were found both in Liberia and in the Belgian Congo, in *Cercopithecus diana, C. nictitans,* and in the red *Colobus rufomitratus* monkey. These parasites have been particularly studied by Theiler and are described and illustrated in Chapter XXX, No. 400 (Figs. 1–13). Many species of monkeys have been found to be susceptible to infection with malarial parasites and Macfie [1] has recently emphasized the fact that there is definite evidence that such infections may cause serious illness or even result in the death of the host.

Many of the descriptions and illustrations of the various malarial parasites of primates that have been published, and the collected studies of them by Doflein [2] and Wenyon [3] show that there is a very striking resemblance between such plasmodia of human beings and of monkeys. At least ten species of malarial parasites have been reported to occur in monkeys. Leger [4] has described and named the most recent one *Plasmodium joyeuxi* n. sp. which he found in *Cercopithecus callitrichus* on the West African Coast. However, it is questionable how many of these are distinct species. Certain of the parasites in monkeys resemble so closely those that occur in man that they are morphologically indistinguishable. Thus, as Hegner [5] points out, *Plasmodium kochi* is similar to *P. vivax,* the tertian parasite of man, both in the structure of the various stages and in the length of the asexual cycle (48 hours). Other so-called species that resemble *P. vivax* are *P. inui* (Halberstadter and Prowazek, 1907) and *P. cynomolgi* (Mayer, 1908) from *Macacus* monkeys: *P. bouilliezi* (Leger, 1922) from *Cercopithecus campbelli: P. semnopitheci* (Knowles, 1919) from *Semnopithecus entellus:* and *P. pitheci* (Halberstadter and Prowazek, 1907) from the orang. *P. brasilianum* recorded by Gonder and Gossler (1908) from a Brazilian monkey, *Brachyurus calvus*, resembles *P. malariae*, the parasite of quartan malaria in man, and *P. reichenowi* (Sluiter, Swellengrebel, and Ihle, 1922) is said to be similar to *P. falciparum* of human estivo-autumnal malaria.

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[1] Macfie: Proc. Royal Soc. Med., Sec. Trop. Dis. (1928), XXI, 467.

[2] Doflein: "Lehrbuch der Protozoenkunde" (1911), p. 791.

[3] Wenyon: "Protozoology" (1926), II, 970.

[4] Leger: Ann. Inst. Pasteur (1928), XLII, 770.

[5] Hegner: Quarterly Review Biology (1928), III, 237.

Reichenow [1] in the study of chimpanzees and gorillas in the Cameroons reported that he had found in these animals three species of *Plasmodium* which he regarded as identical with the three human species. These apes were said to live in the vicinity of human habitations and were liable to be bitten by infected mosquitoes. He says that he found forms corresponding in every way with *P. falciparum* and that the parasites in the animals are indistinguishable from those found in negroes. However, a number of observers were not convinced by Reichenow's observations.

The parasites of the chimpanzee have more recently been studied by Blacklock and Adler [2] in West Africa. They observed in the blood of these animals large amoeboid forms like those of *P. vivax* in enlarged and pale red cells, large more or less banded forms with coarse pigment like *P. malariae*, small ring forms in red cells of normal size and color resembling ring forms of *P. falciparum*, and gametocytes of crescent form indistinguishable from those of *P. falciparum*. However, no segmenting forms were seen in the blood.

Although there is such morphological similarity, the results obtained by cross infection experiments suggest that host-parasite specificity among the malarial organisms in monkeys and man is usually rather rigid. Thus Gonder and Rodenwaldt [3] attempted to inoculate two human beings with *P. kochi*, but the results were not successful. Blacklock and Adler [4] also made unsuccessful attempts to infect two human beings by subcutaneous and intravenous inoculations of blood from a chimpanzee infected with the parasites. In additional experiments they also failed to infect a young chimpanzee by inoculating human blood containing *P. falciparum*. On the other hand, Mesnil and Roubaud [5] have reported upon the successful inoculation of *P. vivax* in the chimpanzee. Recently Yoshino [6] has claimed that he could successfully inoculate puppies and guinea pigs with *P. vivax* if young animals were used. Zia and Faust [7] have attempted to repeat these experiments and have utilized hamsters, rabbits and guinea pigs which were about two months old. They also employed what they regarded as provocative measures consisting of splenectomy and the injection of strychnine nitrate a short time before or after the inoculation of the animal with infected human blood. The injected blood was taken from patients suffering with acute attacks of *P. vivax* or *Laverania malariae* infection and parasites were present in large numbers. The organisms were injected subcutaneously or intraperitoneally but they were unable to infect any of the animals. Steinfeld [8] has also shown in two instances that the removal of the spleen in apes did not lower their resistance sufficiently to permit of their infection with human blood containing the malarial parasites of quartan and aestivo-autumnal type.

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[1] Reichenow: Centralb. Bakt. u. Parasit. (1920–1921), LXXXV, 207; Doflein's "Lehrbuch der Protozoenkunde" (1929), p. 997.

[2] Blacklock and Adler: Ann. Trop. Med. and Parasit. (1922), XVI, 99.

[3] Gonder and Rodenwaldt: Centralb. Bakt. u. Parasit. (1910), LIV, 236.

[4] Blacklock and Adler: *Loc. cit.*

[5] Mesnil and Roubaud: Ann. Inst. Pasteur (1920), XXXIV, 472.

[6] Yoshino: Arch. f. Schiffs-u. Tropen-Hyg. (1926), XXX, 624.

[7] Zia and Faust: Rivista di Malariologia (1928), VII, 301.

[8] Steinfeld: Arch. f. Schiffs-u. Tropen-Hyg. (1929), XXXIII, 592.

Halberstadter and Prowazek (1907) were successful in transferring *P. pitheci* from orang to orang but not to lower monkeys. They also transmitted *P. inui* from one *Macacus* monkey to another, but not to orangs. Mayer (1908) reported successful inoculations of *P. cynomolgi* into *Macacus cynomolgus, M. rhesus* and a species of *Cercopithecus.* Leger and Bouilliez (1912) were able to infect four species of *Macacus,* three species of *Cercopithecus,* and *Papio anabis* with *P. inui,* but failed to infect *C. fuliginosus* and two chimpanzees.

Blacklock and Adler also failed to infect the mosquito *Anopheles costalis* after feeding it upon a chimpanzee infected with malarial parasites.

The question of whether monkeys may act as hosts for the malarial parasites of man is obviously an important one, for in parts of Africa, the Ituri Forest for example, plasmodial infection of monkeys is not uncommon. While most authorities agree that in many instances no morphological differences in the malarial parasites in man or monkey can be distinguished, since the parasites of monkeys have not yet been successfully inoculated into man, the human and the monkey species cannot definitely be regarded as identical. However, it seems possible that the relationship between them may be somewhat similar to that between the human and animal trypanosomes. It will be recalled that Taute and Huber failed to infect one hundred and thirty-one human beings by the inoculation of blood containing animal trypanosomes (*T. brucei* or *rhodesiense*). Therefore no very sweeping conclusions regarding host specificity can be drawn from the inoculation of two human beings with the blood of a chimpanzee on two different occasions. In some of the experiments the individuals might have been immune or the parasites at the time of inoculation might not have been in virulent form and apparently no control animal was inoculated with a portion of the same blood employed in the human experiments.

The Bat, Petalia grandis. — In Liberia, also, plasmodia were found by us in the blood of the bat, a species of *Petalia* (or *Nycteris*) *grandis* (Illustration No. 400, page 492). Dionisi,[1] as early as 1899, described two plasmodia occurring in the blood of bats, one of which he named *Plasmodium murinum* and the other *Plasmodium melanipherum.* These were said to resemble somewhat in their morphology the quartan plasmodium in man, *Plasmodium malariae.*

Other Animals. — Rodhain, Bequaert, Pons, and Van den Branden [2] have also found in the Belgian Congo a similar plasmodium, *Plasmodium brodeni* in the blood of the jumping rat, *Petrodromus tetradactylus,* and Rodhain [3] in the same region, another similar one of the *P. malariae* type in the blood of the epaulet bat *Epomophorus franqueti.* The flying fox in Australia Breinl found was parasitized by a species of *Plasmodium* resembling *P. vivax* of man. Laveran [4] has also described a species of *Plasmodium* which was discovered by Vassal in a squirrel in

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[1] Dionisi: Arch. Ital. de Biol. (1899), XXXIII, 153.

[2] Rodhain, Bequaert, Pons, and Van den Branden: Bull. Soc. Path. Exot. (1913), VI, 182.

[3] Rodhain: Bull. Soc. Path. Exot. (1915), VIII, 726.

[4] Laveran: Comp. Soc. Biol. (1905), LVIII, 350.

Annam. While this parasite resembled *P. malariae* morphologically, it was not inoculable either into man or other animals.

The following list compiled by Theiler, the zoological determinations being made generally by Allen, gives the animals in which Haematozoa were observed during the Expedition:

Plasmodium

Cercopithecus diana
Cercopithecus nictitans
Colobus rufomitratus
Petalia grandis

Haemogregarine

Crocodilus cataphractus
Osteolaemus tetraspis
Tree Snake Specimen not identified.
Dendraspis viridis
Bufo regularis

Haemoproteus

Agama colonorum
Kingfisher, 136, *Halcyon senegalensis fuscopileus*
Bird, 51, *Gymnobucco calvus calvus*
Bird, 55, *Pyromelana hordacea hordacea*
Bird, 64, *Streptopelia semitorquata erythrophrys*
Bird, Bee-eater, *Melittophagus gularis gularis*

From this list it may be seen that we did not find plasmodia in other mammals than monkeys. Some years ago Bruce [1] and his co-workers found a *Plasmodium* in the blood of the duiker in East Africa resembling *P. malariae* in morphology which they named *P. cephalophi.* Sheather [2] in India also encountered a *Plasmodium* in the blood of the buffalo resembling *P. malariae* which he called *P. bubalis,* and De Mello and Paes [3] have described one in the blood corpuscles of goats which they named *P. caprae* and which morphologically resembled *P. falciparum.* In addition Castellani and Chalmers [4] have reported upon a *Plasmodium* in dogs in India, *P. canis,* resembling morphologically *P. vivax* in man, and another species in the horse *P. equi.* Some of these parasites have been illustrated recently by Wenyon.[5] We have had no experience with any of these species in the larger mammals and regard them as either exceedingly rare or in some cases as perhaps mistaken observations. Although blood examinations were made of all the wild game that we shot in Africa, no *Plasmodium* was found in any of them.

A number of piroplasmata have also been described in mammals. Those which have been discovered in carnivora are: *Babesia canis* (Piana and Galli-Valerio, 1895) in the dog, *Canis familiaris; B. gibsoni* (Patton, 1910) in the jackal, *C. aureus,* and *B. rossi* (Nuttall, 1910) in the African jackal, *C. adustus; B. herpestidis* (França, 1908) in the Portuguese mongoose, *Herpestes ichneumon,* and *B. legeri* (Bédier, 1924) in the African mongoose, *H. galera; B. bauryi* (Leger and Bédier, 1922) in the fox, *Fennecus dorsalis; Nuttalia civettae* (A. & M. Leger, 1920) in the Senegalese civet-cat, *Viverra civetta* Pucheran; and *Babesia felis* in the Sudanese wild cat, *Felis ocreata* (Davis, 1929). Davis [6] has shown that the *Babesia* which he discovered is readily transmissible to the domestic cat by means of blood inoculation.

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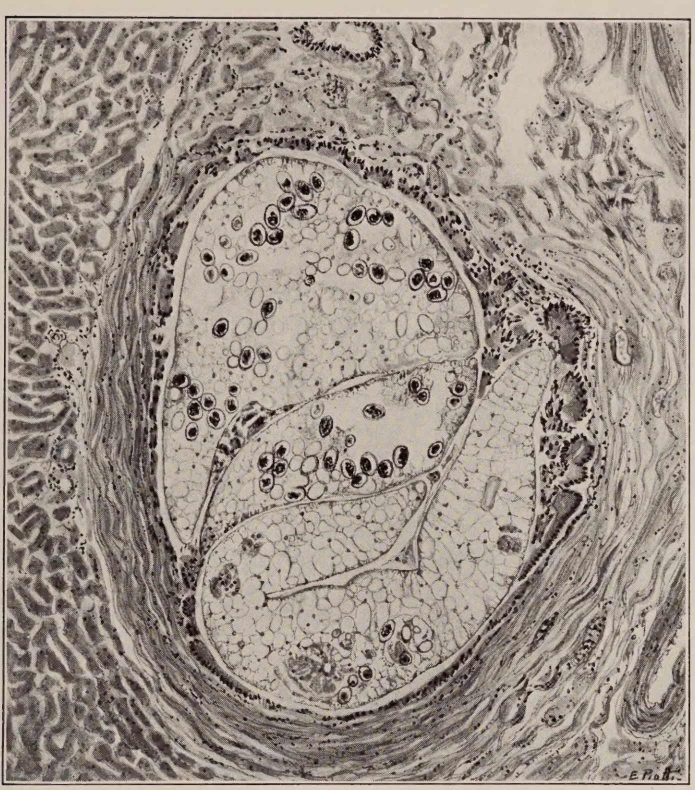
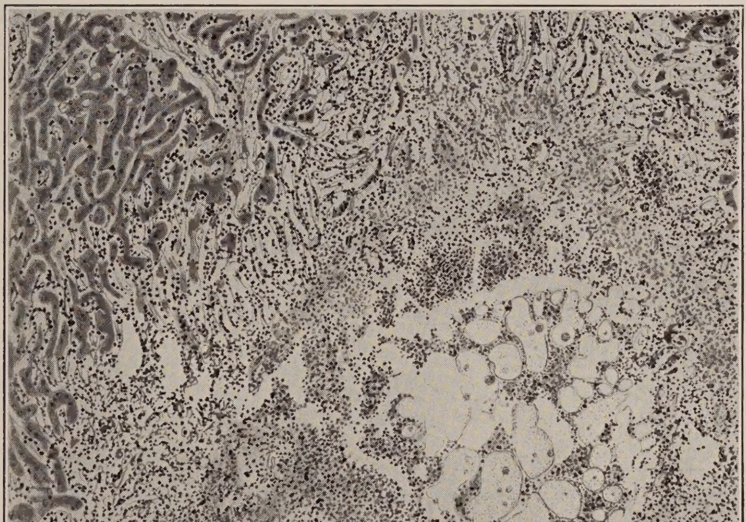
[1] Bruce: Proc. Royal Soc. (1913), LXXXVII, 45.
[2] Sheather: Jour. Comp. Path. Ther. (1919), XXXII, 223.
[3] De Mello and Paes: Comp. Rend. Soc. Biol. (1923), LXXXVIII, 829.
[4] Castellani and Chalmers: "Manual of Tropical Medicine," 1910.
[5] Wenyon: *Loc. cit.*, p. 974.
[6] Davis: Trans. Royal Soc. Trop. Med. and Hyg. (1929), XXII, 523.

Helminthic Infections of Monkeys

A number of other parasitic infections were observed in monkeys. In a red *Colobus* (*rufomitratus*) monkey in the Ituri Forest, a severe infection of the liver with trematodes was observed. At the necropsy the liver contained a number of small whitish areas from 3 to 4 mm. in length and one infarct 4 mm. in diameter, irregular in outline and almost quadrilateral in shape. Small trematodes, approximately 3 to 4 mm. in length, were found in many parts of the liver particularly in the whitish areas or in the greatly distended bile ducts from which many of them could be easily expressed. The spleen was not particularly enlarged but was very dark in color. Examination of the blood films of this animal later revealed a malarial plasmodium. Slices of the liver were placed in Zenker's solution and the trematodes removed from the liver were also hardened in Zenker's solution and in formalin. A small number of nematodes (*Trichuris trichiura*) were also found in the caecum and large intestine of this animal and placed in formalin (see page 478). Histological study of sections of the monkey's liver upon our return showed that many of the bile ducts were prominent and greatly distended in size and often contained sections of the trematodes lying within them (No. 350). Many of the parasites in the tissues contained ova. The epithelium lining the ducts in such cases was compressed, degenerated or destroyed. There was frequently some infiltration of round cells and leucocytes about the walls of the ducts. In some areas the connective tissue surrounding the bile ducts showed evidence of proliferation and distinct thickening and in places this tissue was also infiltrated with round cells. The surrounding hepatic tissue was compressed by this new growth and the liver cells showed cloudy swelling, and in other areas moderate fatty degeneration. About some of the parasites which had apparently died and were themselves degenerating, there was very marked necrosis of the liver and very extensive infiltration of the tissue with polymorphonuclear and endothelial leucocytes, more or less surrounded by areas of round cell infiltration (No. 351). In some areas the liver showed evidences of chronic passive congestion with extravasation of red blood corpuscles, the liver cells being pushed apart and the capillaries widened. There was also evidence of proliferation of the epithelium of some of the bile ducts, but no adenomatous growth was anywhere observed. The endothelial cells about some of the blood vessels were proliferated and there was likewise evidence of a fine cirrhosis in parts of the liver. In still other areas there were numerous newly-formed bile canaliculi. In the regions of more normal liver tissue, away from the sections of the trematodes, miliary areas composed of round cells were not infrequently present. These areas are somewhat similar to those observed in the liver of human cases of diphtheria. They especially suggest that the parasite is able not only to produce pathological changes mechanically by its presence in the bile ducts and tissues, particularly through pressure, but also through some toxic secretion. The liver of this monkey showed evidences of very extensive

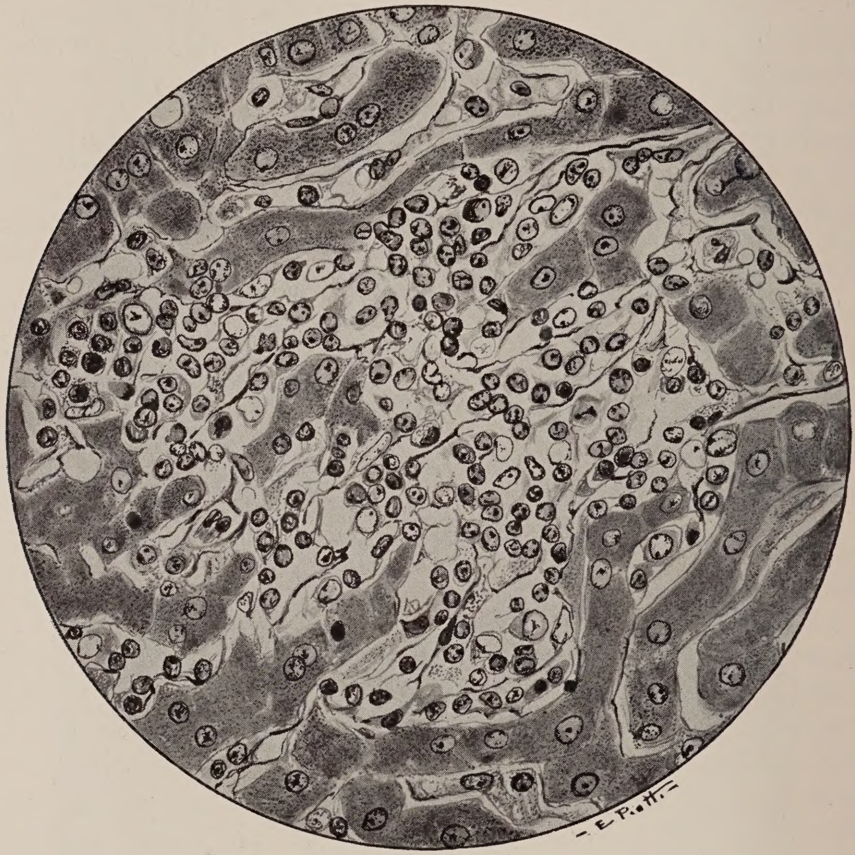


No. 350. — Parasites within distended bile ducts. Zeiss objective AA, ocular 4



No. 351. Degenerated parasite; infiltration and necrosis of liver tissue. Zeiss objective AA, ocular 4

Drawings of sections of liver of monkey illustrating infection with *Dicrocoelium colobusicola* disease. A fair number of degenerating malarial parasites and considerable malarial pigment were also observed in endothelial leucocytes. The trematodes themselves in the liver were turned over to Dr. Sandground, the helminthologist of the department, who after studying the parasite reports that it is a new species of trematode which he has described under the name of *Dicrocoelium colobusicola* (page 463). Sandground points out that this species is a typical member of the genus *Dicrocoelium*, Dujardin, 1845. The species of this genus are numerous and have been found distributed in mammals, birds, and reptiles, usually within the liver and bile ducts.



No. 352. — Drawing of section of liver of monkey. *Dicrocoelium colobusicola* infection, illustrating early inflammatory lesion of the liver. Zeiss objective DD, ocular 10x

Stiles, in his Key Catalogue, lists *Dicrocoelium lanceatum* and of *D. dendriticum* as infecting man. With reference to *Dicrocoelium lanceatum* he [1] states that while the parasite is quite common in cattle and sheep, only about seven cases of its occurrence in man have been reported. Since this time, however, additional cases have been reported by Pigoulewsky.[2] Nevertheless, it is doubtless purely an incidental parasite for man and as only light infections are likely to occur it is probably not a serious human parasite.

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[1] Stiles: "Osler's Modern Medicine" (1925), II, 516.

[2] Pigoulewsky: Trop. Dis. Bull. (1928), XXV, 455.

With reference to the occasional occurrence of *Dicrocoelium lanceatum* in man, the investigations of Strom [1] are of interest. In making helminthological investigations of the population in Turkestan he found the eggs of *D. lanceatum* in thirty-seven cases, of *Fasciola hepatica* in four cases, and of *Opisthorchis felineus* in one case. In the absence of any symptoms of disease of the liver in many cases and failure to find the eggs of the trematodes in repeated examinations, the idea suggested itself to him that he was dealing with spurious distomiasis infection, resulting from the introduction of the eggs into the human intestine by consumption of the liver of cattle infected with the trematodes. That these really were cases of transient occurrence of the ova was proved by Strom and his associate by consuming liver infected with *Dicrocoelium lanceatum* and *Fasciola hepatica.* Following this ingestion of liver they discovered the eggs of these parasites in their faeces and the eggs remained there during three to four days, but in gradually decreasing numbers. Therefore they point out that the mere finding upon one occasion of eggs from trematodes of the liver in the faeces does not prove that the individual is suffering from hepatic infection. They suggest that some of the cases which have been reported as infections with *D. lanceatum* or *F. hepaticum* in man, may not be cases of real infection.

Stunkard [2] has reported upon the liver fluke *Athesmia foxi* infecting an American monkey, *Cebus apella.* This fluke is related to *Dicrocoelium dendriticum.* The parasites were found in the hepatic and interlobular bile ducts. The common bile duct, cystic duct and gall bladder were not parasitized, the biliary ducts appearing to be the chief seat of infection. It is pointed out that although they must have occasioned considerable occlusion of the hepatic ducts, the movement of the worms probably prevented chronic retention of the bile and there was no marked cirrhosis of the liver. Stunkard thinks that it is entirely probable that *Athesmia foxi* is a normal human parasite in its original location, which was apparently British Guiana, South America.

Several other species of intestinal parasites were also found by us in monkeys. Among these were *Trichocephalus* (= *Trichuris*) *trichiura* found in the caecum of *Colobus rufomitratus* and in *Cercopithecus diana.* Schwartz [3] who has recently studied this genus points out that there are no constant differences in the parasites of this genus from man, chimpanzee, species of *Cercopithecus*, and swine, although considerable variations are sometimes observed in individual worms.

Another nematode observed in the intestine of another *Colobus rufomitratus* monkey is *Enterobius* (*Oxyuris*). Unfortunately all the specimens collected from this monkey were females, so that accurate specific determination is not possible. They are somewhat smaller than those of *Enterobius bipapillatus* described by Gedoelst from the intestine of the monkey in the Congo, otherwise the structure of the female appears to coincide very well with this species. At least three species of this genus of nematodes have previously been reported from primates.

No microscopical lesions in the intestines of the monkeys infected with either

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[1] Strom: Extrait de la Revue de Microbiologie et d'Epidémiologie (1927), VI, 6.

[2] Stunkard: Jour. Parasit. (1923), X, 71.

[3] Schwartz: Jour. Agr. Research (1926), III, 311.

Enterobius or *Trichuris* were observed. The action of these nematodes in monkeys is apparently similar to that of the corresponding species in man.

A third intestinal nematode was found in two specimens of *Cercopithecus diana* from the Du River, Liberia. Sandground finds that this parasite appears to belong to the genus *Streptopharagus,* of which four or possibly five species have been described. All of these with but one exception are parasites of primates. After a study of the material from the present monkeys he has decided that the parasite corresponds more closely with the species *Streptopharagus pigmentatus* v. Linstow than it does with any of the other species which have previously been reported from *Macacus.* No pathogenic action apparently can be attributed to this nematode.

In another *Colobus* monkey (*C. polykomos*) two species of nematodes were found in the small intestine. One of these was *Trichuris.* The second nematode has been studied by Sandground, who has found it necessary to create a new genus and species for it. With reference to the systematic disposition of this parasite, he says that its characteristics cannot be reconciled with those of any known genus of the Strongyloidea. On the basis of the shape of the buccal cavity and the associated oral structures the status of the parasite would seem to fall between the two chief subfamilies, the Strongylinae and the Trichoneminae, but in other characteristics it exhibits affinities with the Oesophagostominae. The description of this parasite, *Colobostrongylus strongi* (Sandground), is given on page 469.

In the small intestine of the monkey from which these parasites came there were observed a number of rounded plaques with slight thickening which suggested the possibility of an old *Oesophagostomum* infection. However, no distinct cysts were present. On account of the fact that these areas were so numerous, a hyperplasia concerning lymphoid tissue was thought of. In order to be sure no nematode was concerned in the lesions, a section of one of these areas was made and microscopically examined by Dr. Theiler. No parasites or ova were found. Pieces of the intestine of this monkey and of the spleen were fixed in Zenker's solution. Examination of the stained sections shows that there are areas in the submucosa which stain deeply blue with a basic stain. Microscopical examination reveals that these constitute lymph follicles which are considerably swollen and in which lymphoid cells have greatly proliferated. The hyperplasia of these follicles is apparently not associated in any way with nematode infection. They obviously were not concerned with *Oesophagostomum.* In another monkey that we secured in Africa in which *Colobostrongylus* was not encountered there was a rich *Balantidium* infection of the intestine. The surface of the mucous membrane in this instance showed considerable catarrhal inflammation in places, but in general appeared to be intact. There were no distinct ulcerations to be seen in the sections, but in a few places the mucous membrane had become eroded and the parasites had penetrated into these regions. There was also a very marked cellular infiltration of the mucous membrane, particularly with round cells and eosinophils which were very numerous. In some of the lymph follicles where the proliferation was very apparent, infusoria were found in the follicles or about them and in some instances the nuclei of the infusoria were seen, the surrounding protoplasm of the parasite having disappeared. The parasites were also found deep in the submucosa, sometimes in clusters and along the intramuscular septa. It is impossible not to associate the lymphoid hyperplasia to some extent with the *Balantidium* in this case, though it must be admitted that since such lymphoid hyperplasia is often not present in balantidial infection in other animals or in man, and since there was similar, though less extensive lymphoid hyperplasia in the monkey infected with *Colobostrongylus,* both of these animals in question may have possessed special predilection to proliferation of lymphoid tissue, under the influence of slightly irritating conditions. Unfortunately no sections from the other organs of this animal were preserved and the spleen tissue appears to have been lost in some way among the very large amount of material collected in Africa during the year. Fox[1] has recently encountered, in a necropsy upon a monkey, a great overgrowth of lymphatic tissue which in the absence of any definite tumor suggested a diagnosis of chronic lymphatic leukemia. However, lymphatic leukemia was not suggested by the blood examination of the two monkeys to which we have just referred.

Parasites of Man Infecting Monkeys. Among the more important helminthic parasites of man which have been noted occasionally to occur in monkeys, or *vice versa,* are the following:

Trematoda: Schistosoma haematobium in *Cercocebus fuliginosus; Watsonius watsoni* in *Cercopithecus callitrichus.*

Cestoda: Bertiella satyri (= *B. studeri*) in *Cynomolgus sinicus, C. fascicularis, Cercopithecus pygerythrus, C. schmidti, Hylobates hooloch* and in *Simia satyrus* (= *Pongo pygmaeus*); the pleropercoid larva of *Diphyllobothrium mansoni* in *Macacus nemestrinus, M. furcatus* and *Cynomolgus fascicularis;* the larva of *Multiceps multiceps* in *Macacus rhesus, M. silenus,* etc.; the larva of *Echinococcus granulosus* in *Macacus innuus* (= *sylvanus*), *M. rhesus, Papio porcarius, Cynomolgus fascicularis* (= *Macacus cynomolgus*), etc.; *Cysticercus cellulosae* in *Cercopithecus cephus, C. patas* (= *Simia rubra*), *Macacus inuus.*

Nematoda: Trichocephalus (= *Trichuris*) *trichiura* in various Old-World monkeys; *Oesophagostomum brumpti* in *Macacus rhesus* and *Cercopithecus callitrichus; O. stephanostomum* in *Pan satyrus; Ternidens diminutus* in *Cynomolgus sinicus, C. fascicularis, Macacus cynomolgus* and *Gorilla beringei; Necator americanus* in *Cercopithecus ruber, C. patas, Pan* (= *Simia*) *satyrus* and *Gorilla beringei; Ancylostoma duodenale* in *Macacus sinicus; Strongyloides intestinalis* in *Silenus* (= *Macacus* = *Pithecus* = *Cynomolgus*) *philippinensis, Pan troglodytes, Pongo pygmaeus, Silenus* (*irus, cynomolgus, nemestrinus, rhesus, sinicus*), *Cercopithecus* (species), *Cynocephalus* (species); *Trichostrongylus colubriformis* in *Papio hamadryas; Physaloptera mordens* in *Macacus sinicus; Acanthocheilonema perstans* in *Pan satyrus; Füllebornius medinensis* in the baboon, *Papio cynocephalus, Papio hamadryas,* and *Cercopithecus callitrichus; Ascaris lumbricoides in Pan satyrus; Filaria loa* in *Papio* (species); *Gongylonema* in *Macacus* (*sylvanus* s. *inuus*) and *Silenus* (*sinicus*).

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[1] Fox: Zoological Society of Philadelphia. 57th Annual Report. (1929), p. 44.

Linguatulida: The larva of *Porocephalus armillatus* in *Cercopithecus albogularis, Cynocephalus maimon, Macacus cynomolgus, M. fascicularis* and *M. rhesus, Mycticebus tardigradus,* and *Papio sphinx,* and the larva of *P. moniliformis* in *Cynomolgus fascicularis.*

We have already called attention on page 412 to the haematozoa affecting primates. Other protozoa of man which have been found particularly infecting monkeys are *Balantidium coli* in *Cebus variegatus, Cynomolgus fascicularis, Cercocebus fuliginosus, Colobus polykomos,* in the baboon *Papio sphinx,* in the chimpanzee *Anthropopithecus troglodytes,* and in the orang-outang *Simia satyrus; Entamoeba histolytica* in *Ateles geoffroyi, Anthropopithecus troglodytes, Macacus (Pithecus) philippinensis,* and *M. rhesus; Entamoeba coli, Endolimax nana, Iodamoeba williamsi* in *Macacus (Pithecus) philippinensis; Endamoeba gingivalis* in *Macacus rhesus* and *M. cynomolgus.* A number of intestinal flagellates have also been encountered in monkeys. In one instance Bruce and his co-workers found what they believed to be *Trypanosoma gambiense* in a monkey, *Cercopithecus pygerythrus centralis,* from the shores of Lake Victoria.[1] Wenyon [2] has given a list of the other trypanosomes which have been occasionally observed in monkeys. Hegner [3] has recently published a table of these and the other protozoan parasites of man infecting both captive and wild monkeys. He points out that of the twenty-five species of protozoa recognized at the present time as inhabitants of man, seventeen of the twenty-five species have been reported from monkeys. These species were morphologically indistinguishable from the corresponding species that occur in man. Cameron [4] has recently compiled a list of the helminths of man which also have other animal hosts. His partial list of these includes those which infect the domestic animals as well as monkeys, and is therefore referred to here in connection with the subject of the parasites of animals in relation to human disease.

Stiles [5] has also prepared a Key Catalogue of Parasites reported for Primates (Monkeys and Lemurs) and their possible public health importance. This catalogue which appeared while this Report was in press, lists in many instances both natural and experimental infections, but the complete references are not published in this catalogue.

GORILLA

We requested permission to shoot but one gorilla as a specimen for the Zoological Museum of Harvard University and the work of securing this specimen was assigned to Mr. Harold J. Coolidge, Jr., the assistant zoologist of the Expedition. Mr. Coolidge not only secured an excellent specimen for the Museum but also performed a necropsy upon the animal and obtained specimens of a parasite in the intestine. He also prepared blood films from the animal's blood.

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[1] Bruce: Proc. Royal Soc. (1910), LXXXII, 480. Report of Sleeping Sickness Commission, Royal Soc., XI, p. 71.

[2] Wenyon: "Protozoology" (1926), I, 483.

[3] Hegner: Quarterly Rev. of Biology (1928), III, 239; Science (1929), LXX, 539.

[4] Cameron: Proc. Royal Soc. Med. (1927), XX, Parts 1–2, p. 554.

[5] Stiles: U. S. Hygienic Lab. Bull. No. 152 (1929), Washington, D. C.

He has since carried on extensive studies in this country and in Europe with reference to the gorilla and has prepared a most excellent and valuable monographic review of the genus Gorilla published during the preparation of this Report.[1] His article is summarized in Chapter XXXIII.

The parasite from the gorilla proved to be a cestode and was turned over to Dr. Sandground upon our return for further study. About the time that he was completing his study of this material, a preliminary report was published by Nybelin[2] upon a cestode collected from a gorilla of the Kivu volcano region by the Swedish Central African Expedition. While Nybelin's description is apparently not entirely complete, he has given this cestode the name of *Anoplocephala gorillae.* Sandground has made a careful study of the material from the gorilla shot by Mr. Coolidge and has given a more complete description of the species (page 473). Apparently this parasite has not been observed before and Nybelin's and Sandground's descriptions of it are the first to be published.

The parasite is particularly characterized by the absence of the rostrum and by the great width of the segments in comparison to the length. The genital pores are all on one side and the gonads present special characteristics. The parasite bears no close resemblance to the species of *Bertiella,* which Miss Cram[3] recently reported from man and a chimpanzee in Cuba. Other species of the genus *Anoplocephala* (*sensu stricto*) have been found only in herbivora.

Baer[4] has recently prepared a monograph upon the family Anoplocephalidae. He records that six species of *Anoplocephala* have been previously described. To the table which he gives in this monograph, the seventh species from Sandground's description is here added.

Species	*Length mm.*	*Breadth mm.*	*Length of the cirrhus pouch mm.*	*Number of testicles*	*Dimensions of eggs*	*Hosts and Distribution*
A.magna (Abilgaard, 1789).	350	25	1,4	400–500	70–80	Equus caballus, E. asinus, E. burchelli. Cosmopolite.
A. rhodesiensis (Yorke & Southwell, 1921).........	114	22	1	200	100–120	Equus quagga, E. burchelli, E. zebrae. Afrique.
A. perfoliata (Goeze, 1782).	70–30	10–12	0,5	200	65–70	Equus caballus, E. asinus, E. burchelli. Cosmopolite.
A. gigantea (Peters, 1856)..	150	40	0,5–1,5	100–200	77–95	Rhinoceros unicornis, R. simus, R. sondaicus, R. bicornis. Asie & Afrique.
A. spatula (Linstow, 1901).	90	12	0,75–1	200	45	Procavia capensis, P. sp. Heterohyrax brucei. Afrique.
A. manubriata Railliet, Henry et Bauche, 1914........	27	16	1,5–1,8	?	70–80	Elephas indicus. Asie.
A. gorillae Nybelin, 1927...	60–100	9–15	1.24–1.48	Numerous	?	Gorilla gorilla. Belgian Congo.

In addition to the occurrence of *Plasmodium vivax* in the Gorilla already referred to on page 413, infections with *Entamoeba histolytica,*[5] *Ascaris lum-*

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[1] Coolidge: Memoirs, Museum Comp. Zool., Harvard College (1929), L, No. 4, p. 297.

[2] Nybelin: Ark. f. Zoologi (1927), XIXB, 3.

[3] Cram: Amer. Jour. Trop. Med. (1928), VIII, 339.

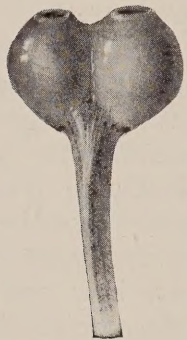
[4] Baer: Supplé. X, Bull. Biol. de France et de Belgique (1927).

[5] Neveu-Lemaire: Ann. de Parasitologie (1927), V, 262.

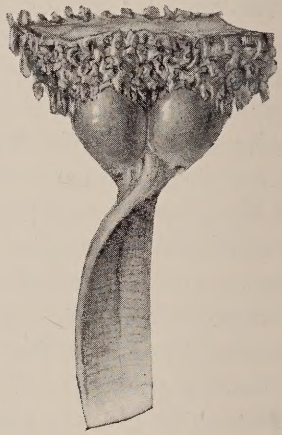
bricoides, Acanthocheilonema perstans, Necator americanus,[1] *Oesophogostomum apiostomum,*[2] *O. stephanostomum* and *Ternidens diminutus* [3] have been reported.[4]

Reptiles

Python sebae. In a python shot as it was crossing the narrow trail, an autopsy was immediately performed. In the stomach were found clusters of nematodes from 4 to 6 in number and approximately 5 to 7 cm. long (not measured) with their heads placed close together and buried in the mucous membrane of the stomach. The mucous membrane of the stomach appeared grayish in color and otherwise normal. In the small intestine just below the stomach another cluster of slightly similar nematodes with their heads buried and adherent to the mucosa were observed. The nematodes together with some of the mucous membrane adherent were placed in alcohol. They were later diagnosed as *Ophidascaris filaria* (see page 426). In the small intestine further on two cestodes which have been identified as *Bothridium ovatum* Diesing, 1850, with their heads adherent to the mucous membrane of the intestine were found. These were also hardened in situ in alcohol. The liver and the lungs appeared to be normal. Film preparations from the liver and lungs and blood showed no haemogregarines or other parasites. Microscopical preparations of the intestinal contents showed no evidences of parasitism except ascarid-like ova of the nematode already referred to.



No. 353. — Camera lucida drawing of *Bothridium ovatum* Diesing 1850, drawing illustrating scolex, showing two sucking organs with anterior acetabular and posterior or basal openings. Magnified about 4 diameters



No. 354. — Camera lucida drawing of anterior end of the parasite attached to villi of intestine

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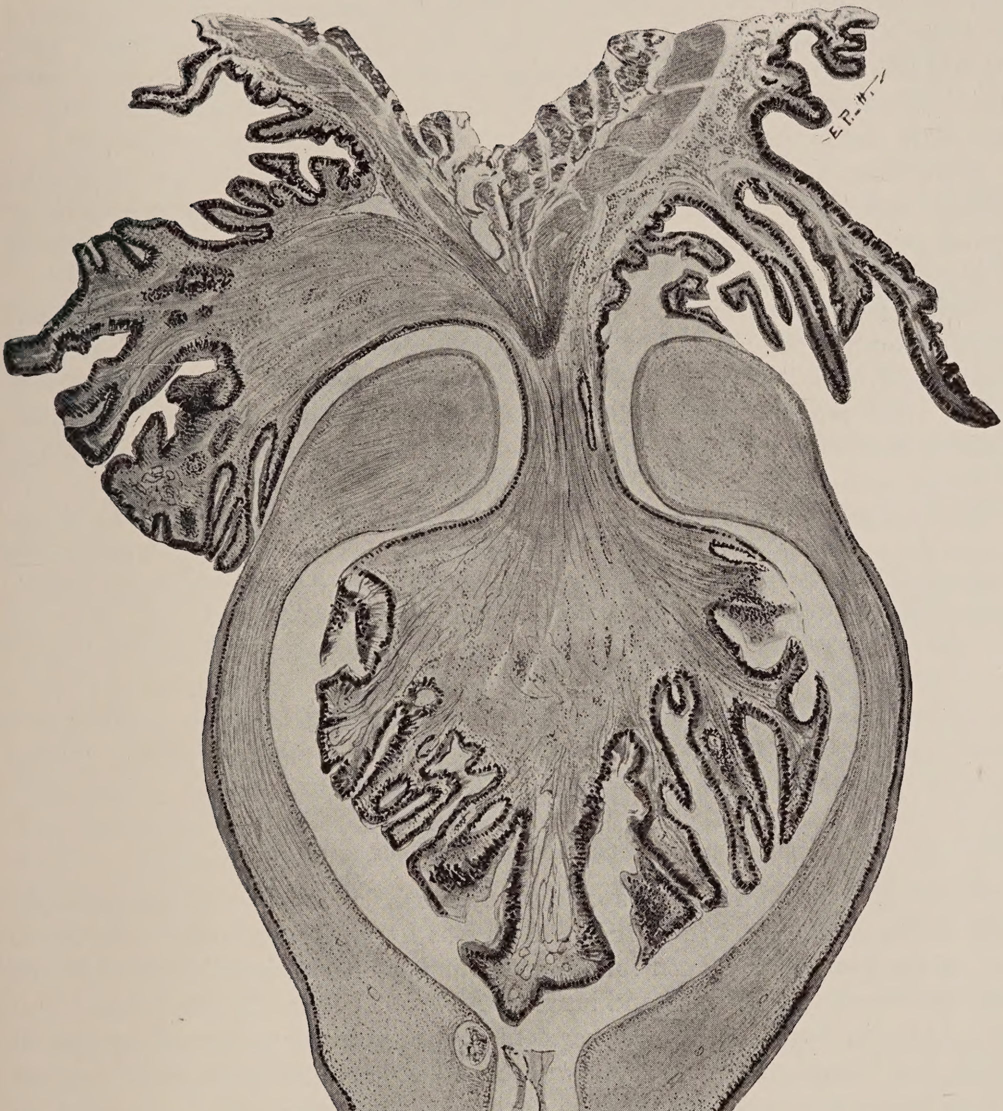
[1] Neveu-Lemaire: Ann. de Parasitologie (1928), VI, 115.

[2] Manson-Bahr: Proc. Royal Soc. Med. (1926), Parts 1–2, p. 42.

[3] Leiper. Jour. Trop. Med. and Hyg. (1908), XI, 182.

[4] Stiles in his Key-Catalogue lists in addition *Ancylostoma duodenale* and *Laverania falcipara,* but gives no references.



No. 355. — Camera lucida drawing of section made through an area represented in No. 354, illustrating mucous membrane and muscularis mucosae of intestinal wall of the python, drawn into the oval sucker of the parasite. Magnified about 28 diameters.

No. 353 illustrates the scolex of this cestode, showing the two sucking organs with anterior acetabula and posterior or basal openings. No. 354 shows the anterior end of the parasite in situ attached to the villi of the small intestine, while No. 355 illustrates a section made through an area represented in No. 354. Here there is illustrated the mucous membrane and muscularis mucosae of the intestinal wall of the python sucked or drawn into the oval sucker of the parasite.

Bothridium ovatum has been found on several occasions before in African pythons and boas. It has recently been made the subject of special study by Joyeux and Baer [1] who have also described *Bothridium pithonis* and a new variety of *B. pithonis parvum.*

Stiles [2] points out that the larval stages for most species of *Bothridium* and *Dibothridium* are unknown, but the parasites have been found in the intestine of mammals, birds, and reptiles. He says that of the six genera,—*Diphyllobothrium* Luehe, 1910 (emend. Braun, 1903) (= *Dibothriocephalus*), *Duthiersia, Scyphocephalus, Bothridium, Diplogonoporus,* and *Pyramidocephalus* — only two (*Diphyllobothrium* and *Diplogonoporus*) have been reported from man.

The nematodes which were collected from our python were found by Sandground to correspond to *Ophidascaris filaria* (Dujardin) Baylis, 1921. The python is the type host of this *Ophidascaris.* Yorke and Maplestone [3] list eight other species, which together with their hosts, are as follows:

O. gestri (Parona, 1890) In *Tropidonotus* sp.
O. intorta (Gedoelst, 1916) In *Bitis* sp.
O. mombasica (Baylis, 1921) In *Psammophis* sp.
O. naiae (Gedoelst, 1916) In *Naja* sp.
O. obconica (Baird, 1860) In *Helicops* sp.
O. papillifera (Linstow, 1898) In snakes
O. radiosa (Schneider, 1866) In *Bitis* sp.
O. solitaria (Linstow, 1903) In *Dipsadomorphus* sp.

In another example of this same species of python, *Armillifer armillatus* Sambon,[4] 1922 (*Porocephalus constrictus* Stiles, 1893) was found in the lungs. The larval form of the parasite has been found on a number of occasions encysted in the liver, mucosa of the intestine and lungs of African natives. Mouchet has found this parasite in more than twenty per cent of the autopsies performed by him in the Central Congo. During the migrations of the parasites in the body they are said to have sometimes given rise to peritonitis and pneumonia. Bequaert on page 798 has listed the Linguatulidae collected during the Expedition which have not yet been identified.

Bitis nasicornis. We also found *Ophidascaris filaria* in the stomach and small intestine of *Bitis nasicornis,* the snake having been speared in the head as it was crossing the trail. A flagellate resembling *Trichomonas* was also observed in fresh film preparations made from the intestine of this snake. In another specimen of this snake adult Linguatulidae were found in the lung.

Dendraspis viridis. A number of other snakes and reptiles were examined for parasites. In *Dendraspis viridis,* a species of tree snake, species of haemogregarines were found in the blood and film preparations made from the spleen and liver. Haemogregarines were also found in *Crocodilus cataphractus* and *Osteolaemus tetraspis* as well as in *Bufo regularis.*

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[1] Joyeux and Baer: Ann. Parasit. (1927), V, 127.

[2] Stiles: Hygienic Laboratory Bull. No. 25 (1906), p. 15.

[3] Yorke and Maplestone: "Nematode Parasites of Vertebrates" (1926), p. 263.

[4] Sambon: Jour. Trop. Med. and Hyg. (1922) XXV, 188.

Other Small Animals

Among other small animals in which parasitic infections were observed were the following:

(1). In a lizard *Agama colonorum* from Liberia a nematode was found in the intestine by Theiler which has been described by Sandground as *Oswaldocruzia agamae,* a new species (see page 468). In five specimens of this lizard the filariid worm *Saurositus agamae* Macfie,[1] 1924, was found in the vascular system. In the intestine of the same lizard were found *Strongylurus brevicaudata* Müller,[2] 1894 (Oxyuroidea), and some very small flukes and a cestode which Sandground was unable to identify owing to shrinkage of the material.

(2). In the lungs of a frog, *Rana fasciola* from Liberia, a species of the trematode *Pneumonoeces* was encountered.

(3). In a bird, *Elanus caeruleus* shot by Allen in Liberia, nematodes were found in the orbital cavity, posterior to the nictitating membrane, which have been described by Sandground as *Oxyspirura elani,* new species (see p. 483).

(4). In a mongoose, *Crossarchus obscurus,* from Liberia, in which small tumor-like cysts, 3 to 5 mm. in diameter, were found in the intestine, each contained a single spiruroid nematode larva coiled in the form of a figure eight. This parasite has been described as a new species by Sandground under the name of *Agamospirura liberiae* (see page 484). In another species of mongoose, *Herpestes albicaudus* which inhabits most parts of Africa except in the north, *Diphyllobothrium latum* has been reported while in *Herpestes ichneumon* of northern Africa, Asia Minor, and Palestine, *Echinococcus granulosus* has been found in the larval stage.

Wild Game

With reference to the parasites of wild game, almost every animal shot was found to be infected with some animal parasite. Just as the rate of intestinal infection among human beings is very high in Africa and in most other portions of the tropical world, so the rate of intestinal parasitic infection is very high in African animals. Parasites were encountered in Thomas's cob, the bush buck, water buck, reed buck, duiker, wart hog, topi, different races of buffalo, hippopotamus, elephant, lion, and leopard, as well as in the monkey, gorilla, and mongoose, and in the cobra, puff adder, and python. One might expect an even higher rate of parasitic infection in animals in Africa than in the human inhabitants, since generally even by instinct animals can protect themselves little against such infections. However, the wild animals have probably acquired through generations of infection greater tolerance or immunity against many of these parasites than has man. Fülleborn and Kikuth [1] have recently considered the immunity and cutaneous immune reactions in helminthic infections. While in a few instances of infestation with animal parasites the modification of the blood of the host is of such a nature that the resulting immunity can be demonstrated by serum reactions, as in the case of some bacterial infections, in more instances of parasitic infection no such immunity can be demonstrated serologically. Nevertheless, it appears that species or races of animals which have harbored a given parasite for a long period of time usually show less marked effects of the result of its presence than species that previously have not been subjected to such infestation. Sandground [2] has recently discussed the factors of age resistance and acquired immunity in helminthic infections of animals, as well as the nature of the immunity or resistance acquired in certain instances. He points out that while a very plausible explanation for the age resistance can be formulated on natural grounds, the elaboration of a hypothesis to account for acquired immunity is much more difficult. Although an animal may acquire an immunity to a specifically normal parasite, as might be expected, the tendency to do this is greater when the species of parasite involved is one in which the host does not have an autochthonous relationship. However, that many animals acquire a definite resistance against certain parasitic infections would appear to be unquestionable. Stunkard,[3] also, has recently given much evidence of this fact.

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[1] Macfie: Ann. Trop. Med. and Parasit. (1924), XVIII, 409.

[2] Müller: "Nematode Parasites of Vertebrates," by Yorke and Maplestone (1926), p. 222.

The more important parasites of wild game, regarding which observations were carried out by us in Africa will now be discussed.

Hyena (*Crocuta crocuta thomasi*). We expected to find animal parasites in the hyena owing especially to the fact that it preys largely upon dying and dead animals. Trypanosomes have been found previously in the hyenas in districts where sleeping sickness is prevalent, and they have been known to carry off and devour the dying sleeping sickness victims from the sleeping sickness camps and lazarettos in some districts in East Africa.[4] We, however, found no trypanosomes in the four hyenas that were examined nor did we find any evidence of animal parasitic infections in them, though special examinations were made of the spleen, blood, and intestinal tract.

Neveu-Lemaire [5] in his article upon the mammals which may serve as the reservoirs for the virus of infectious diseases and for parasites of man only mentions the hyena as a host of the trypanosome of nagana and of the virus of rabies, and refers to the observation of Southwell that it may be a host of *Dipylidium caninum*. Fantham, Stephens and Theobald [6] note the occurrence of the larva of *Porocephalus constrictus* in the earthwolf *Proteles cristatus*, which, however, they have erroneously referred to as a species of hyena.

In one of our hyenas there was a wart-like tumor near the vagina measuring about 2.5 cm. in diameter. A piece of the tumor was preserved in Zenker's solution. The study of stained sections of it has revealed nothing of special interest, the structure is that of a typical wart, with very marked increase of the epithelium, the horny layer being especially thickened and a number of epithelial pearls present. At the necropsy of this animal there were in both the spleen and liver irregular areas which were of a paler red color and particularly soft and friable. It was thought at the time that this condition might be due to a postmortem invasion with *Bacillus aerogenes-capsulatus.* However, examination of stained sections of the spleen did not show any postmortem bacilli but on the contrary an extensive invasion of the organ with a fungus. Both mycelial and spherical forms of the parasite are present in many parts of the tissue. No mycotic infections of the spleen were observed in Africa, with the exception of several postmortem invasions of the organ with fungi.

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[1] Fülleborn and Kikuth: Beihefte, Arch. f. Schiffs-u. Tropen-Hyg. (1929), XXXIII, 168.

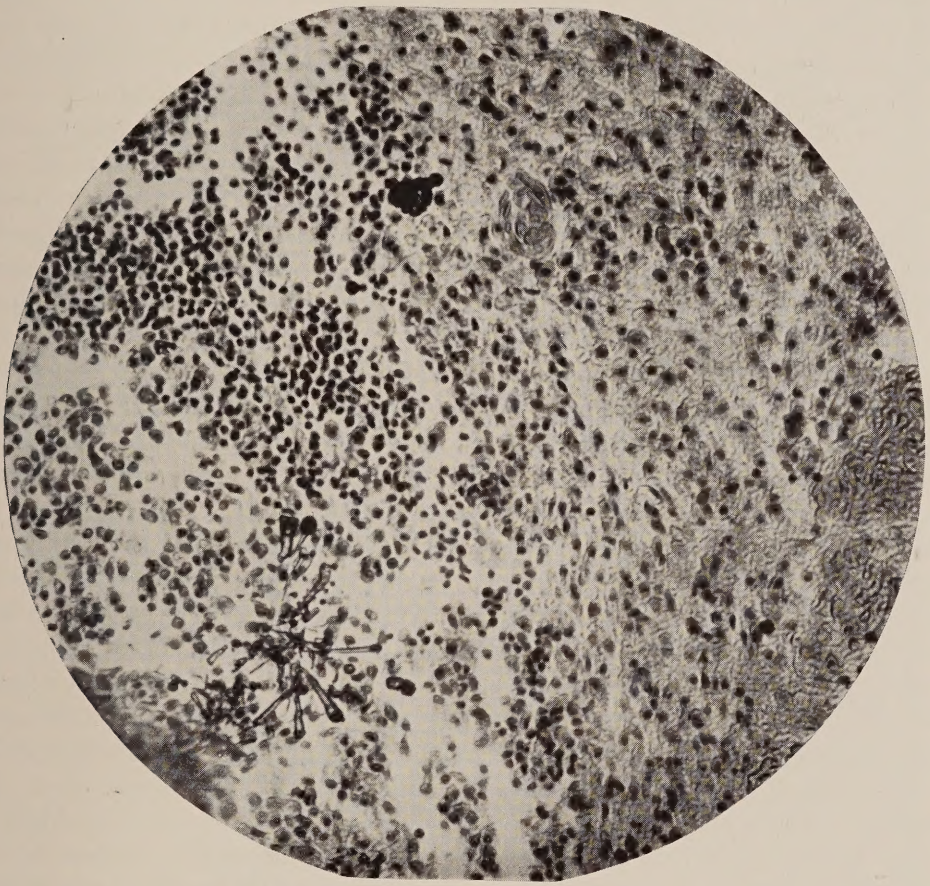
[2] Sandground: Parasitology (1929), XXI, 227.

[3] Stunkard: Scientific Monthly (1929), XXVIII, 349.

[4] Roosevelt and Heller: "Life Histories of African Game Animals" (1914), I, 259.

[5] Neveu-Lemaire: Ann. de Parasit. (1927), V, 254, 378.

[6] Fantham, Stephens and Theobald: "The Animal Parasites of Man" (1916), p. 527.



No. 356. — Photomicrograph of section of the spleen of hyena, *Crocuta thomasi,* showing postmortem infection with fungus. Zeiss objective DD, compensating ocular 6

It may be of general zoological interest to mention that a single almost full-term foetus was found in the uterus of one hyena. Very little, of course, is known of the breeding of hyenas, which is said not to take place in captivity. Roosevelt and Heller [1] and several other authors state that the litter usually consists of two or three members.

Wart Hog (*Phacochoerus africanus* Gmelin). The wart hog (Number 357) is peculiar to Africa. Apparently comparatively little is known in regard to its parasitic fauna, though a few intestinal parasites have been recorded. In an animal shot in the Eastern Belgian Congo, in the Ruchuru Plains, lesions were found in the liver, spleen, and lungs. These measured from 1 to 5 or 6 cm. in diameter. They were slightly raised above the normal surface of the liver or lung and some of them were whitish in color. On section, they proved to be cysts, some with thick walls, many containing fluid under pressure which spurted out when the cyst wall was incised. On microscopical examination of preparations made by scraping the wall of the cysts of the liver, spleen and lungs, scolices possessing a number of minute hooklets were observed. In the lungs some daughter cysts were found within the mother cysts. One gland at the base of the larynx also contained a cyst with a thick wall. The gall bladder was greatly distended with bile, one of the cysts with fibrous growth surrounding it, apparently pressing upon the common bile duct. The gall bladder itself was apparently normal. The tissues were preserved in Zenker's solution and alcohol. Film preparations were made from the liver and spleen. No evidence of infection with other parasites than *Echinococcus* was found. Sections of the tissues upon histological examination show typical structures pertaining to *Echinococcus granulosus* (Nos. 361–363). One sees in places the typical wavy and laminated membrane of the *Echinococcus* cyst wall enclosed in a dense capsule, produced by the surrounding host tissue. Within the laminated membrane may be distinguished the lining multinuclear, parenchymatous or germinal layer of the cyst. In places inside this lining parenchyma the embryonic tissue has separated in its central portion where accumulation of fluid has occurred. From the parenchymatous lining may be seen springing smaller and larger buds which in places are numerous. These smaller buds are sometimes elevated on short stalks, while the larger ones are frequently detached and are present in clusters of from two to six. In the larger spheres, developing scolices can be distinguished. The rostellum in these scolices is already invaginated with the crown of hooklets and in some instances the four suckers, facing downward or inward. Others of these spheres may perhaps be regarded as acephalocysts; at least no structures suggesting scolices can be distinguished in them, although in some the parenchymatous proliferating layer of the cyst can be recognized. There is some infiltration of the tissues of the organs surrounding the fibrous capsule which encloses the parasites and this infiltration is composed particularly of round cells. However, the parenchymatous tissue of the liver, spleen, and lungs, away from the cyst walls, appears to be but little altered. Dévé [2] has recently made a careful study of the cuticulization of the proliferating membrane of *Echinococcus*.

Stiles [3] gives as hosts of the cystic "hydatid" stage of *Echinococcus granulosus*

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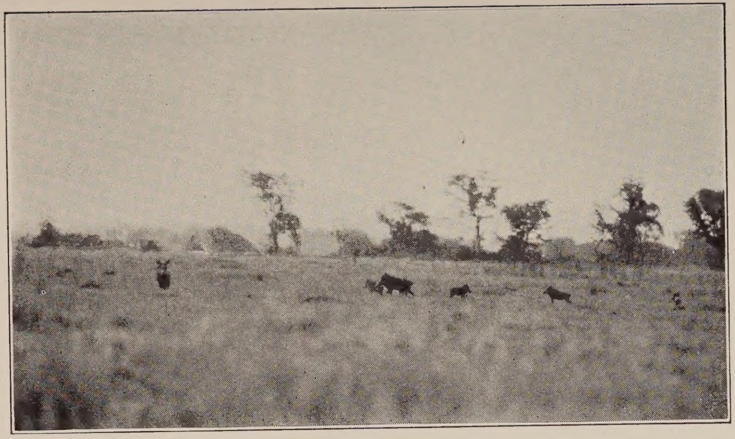
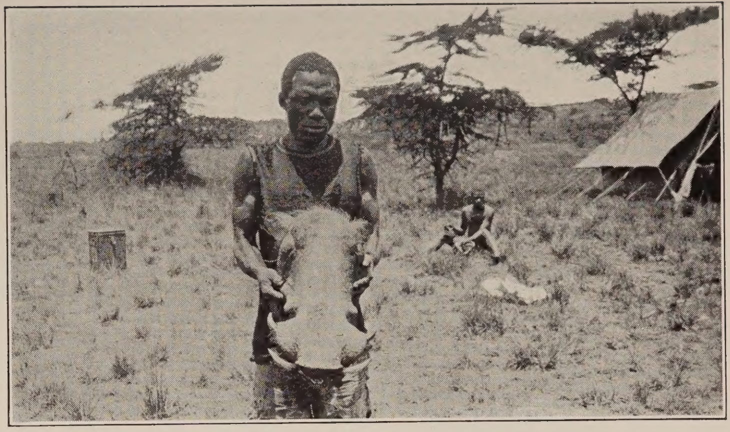
[1] Roosevelt and Heller: *Loc. cit.*

[2] Dévé: Ann. de Parasit. (1927), V, 310.

[3] Stiles: Illustrated Key to the Cestode Parasites of Man. U. S. Hygienic Lab. Bull. No. 25 (1906), p. 76.



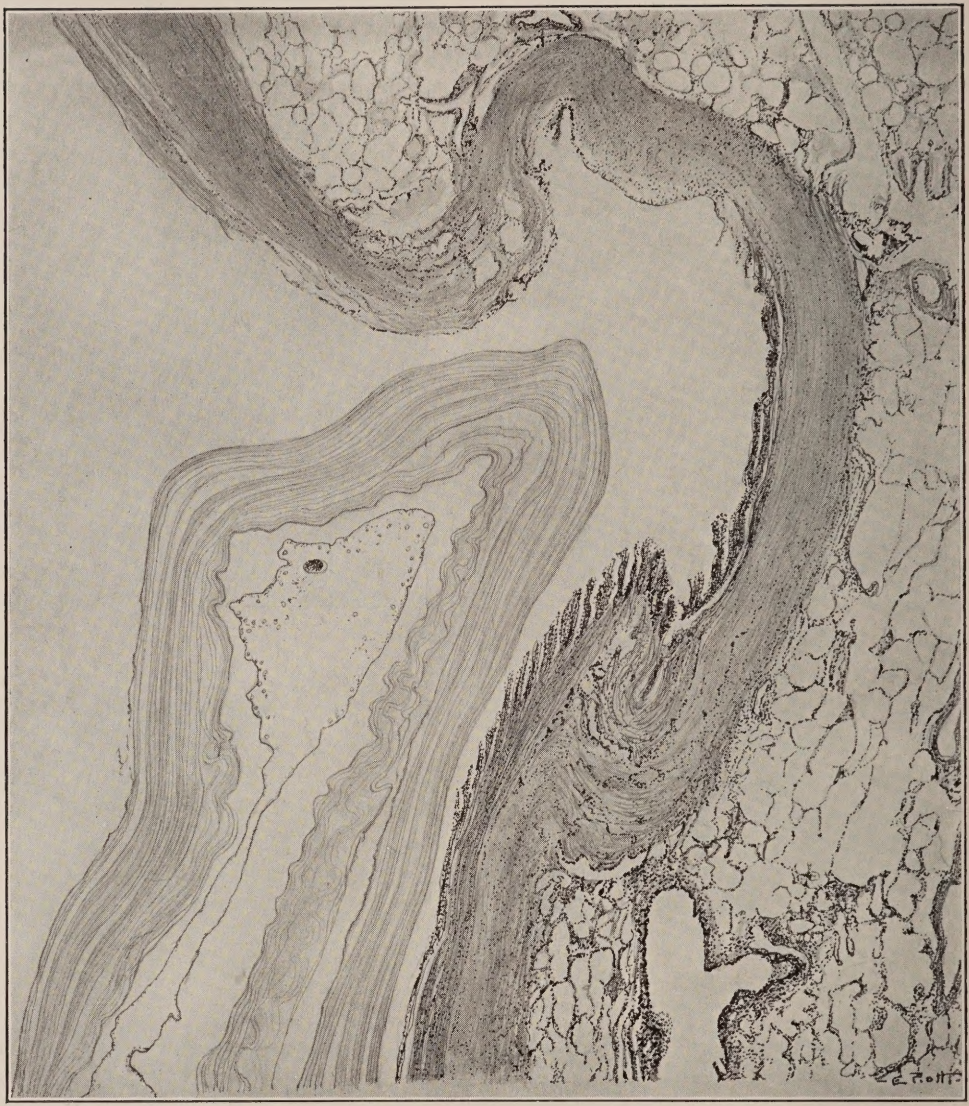
No. 357. — Wart hog, *Phacochoerus africanus*, Ruchuru Plains



No. 358. — Head of wart hog

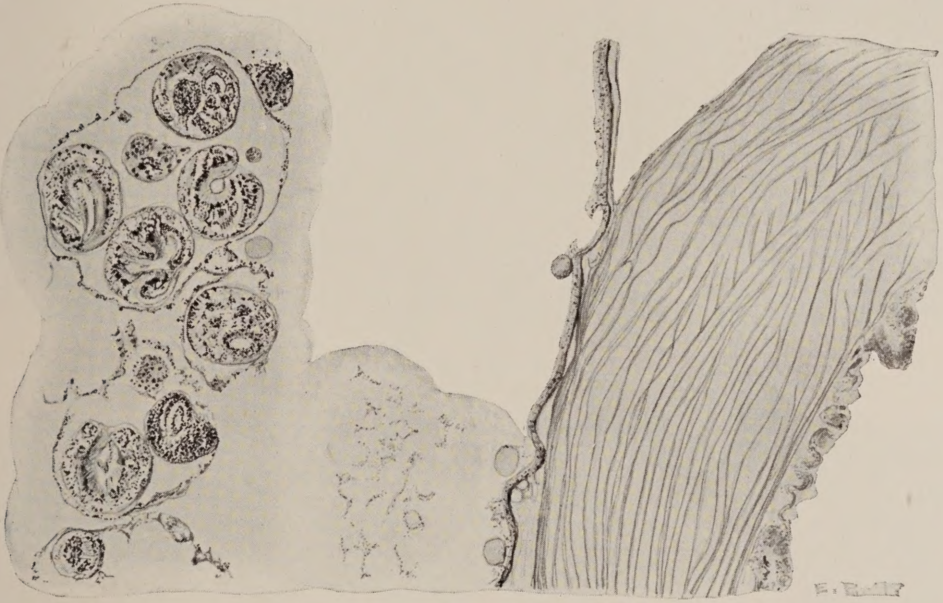
No. 359. — Safari on plains of Ruchuru

No. 360. — Cleaning lion skull and skin after necropsy



No. 361. — Drawing of *Echinococcus granulosus* cysts in the wart hog, *Phacochoerus africanus.* Low power drawing of *Echinococcus* cyst in lung showing dense fibrous cyst wall or capsule, the wavy, laminated membrane of the cyst, as well as the parenchymatous or germinal lining and the formation of daughter cysts and scolices

(Batsch 1786 — Rudolphi 1805) besides *Homo sapiens*, cattle (*Bos taurus*), sheep (*Ovis aries*), goats (*Capra hircus*), swine (*Sus scrofa domestica*). It is also reported for crab-eating macaque (*Macacus cynomolgus*), Indian lion-tailed macaque (*M. silenus*), Barbary macaque (*Inuus inuus*), the argali (*Ovis ammon*), Bactrian camel (*Camelus bactrianus*), dromedary (*C. dromedarius*), giraffe (*Giraffa camelopardalis*), wild boar (*Sus scrofa*), four-horned antelope (*Tetraceros quadricornis*), European elk or moose (*Alces alces*), zebra (*Equus zebra*), horse (*E. caballus*), ass (*E. asinus*), Malayan tapir (*Tapirus indicus*), domesticated dog (*Canis familiaris*), leopard (*Felis pardus*), domesticated cat (*F. catus domestica*), ichneumon (*Herpestes ichneumon*), common European squirrel (*Sciurus vulgaris*), kangaroo (*Macropus major*).



No. 362. — Camera lucida drawing of external laminated wall of *Echinococcus* cyst and germinal layer with several small buds and larger daughter cysts with developing scolices in *Phacochoerus africanus*

In addition to this list, one finds among the hosts cited by Brumpt,[1] (to which we have added the zoological designations) the bear (*Ursus* sp.), panther (*Felis panthera*), mongoose (*Herpestes* sp.), eland (*Taurotragus derbianus*), and rabbit (*Lepus* sp.). He also states there is a possibility of certain birds being infected. Manson-Bahr,[2] in his article on the relationship of wild animals to diseases in man, names as a host for *Echinococcus granulosus*, the wolf (*Canis lupus*) and the jackal (*Canis aureus*). None of these authors mention the wart hog as a host, and apparently this is the first time this parasite has been reported in this animal.

Cameron [3] has recently made observations on the genus *Echinococcus*. He suggests the division of the genus into three species; *E. granulosus*, *E. oligarthra* Diesing, 1863 (Synonym: *E. cruzi* Brumpt and Joyeux, 1924), and *E. longimanubrius*. *E. oligarthra* was found in two species of *Felis*, *F. concolor* and *F. yaguarundi;* while Brumpt found *E. cruzi* in an agouti (*Dasyprocta agouti*), from Brazil. *E. longimanubrius* was described by Cameron as a new species from a Cape hunting dog (*Lycaon capensis*).

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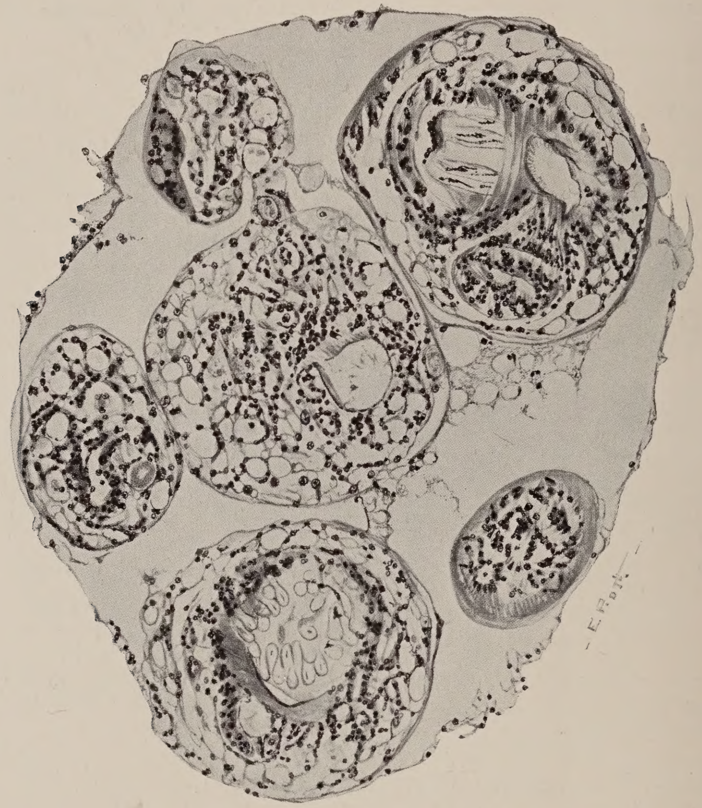
[1] Brumpt: "Précis de Parasitologie" (1927), p. 544.

[2] Manson-Bahr: Proc. Royal Soc. Med., XIX, Parts 1–2, p. 42.

[3] Cameron: Studies London School Trop. Med. (1925–1926), II, 1.

Pathological lesions of wart hogs have not been commonly reported. Fox[1] has recently cited two cases of cerebral affection relating to the pituitary body of the northern wart hog, *Phacochoerus africanus*. In both cases there was bleeding from the nose prior to death. While no tumor formation was present, Fox assumed that simple enlargement of the pituitary might cause sufficient congestion for forced rupture of the vessels, and haemorrhage into the nose, pharynx, and cranial sinuses.



No. 363. — Camera lucida drawing of cysts in different stages of development, and granddaughter cysts in which inverted suckers and hooklets are visible

Stunkard[2] has recently noted the occurrence of the trematode *Gastrodiscus aegyptiacus* (Cobbold, 1876) in the intestine of the wart hog, *Phacochoerus africanus*.

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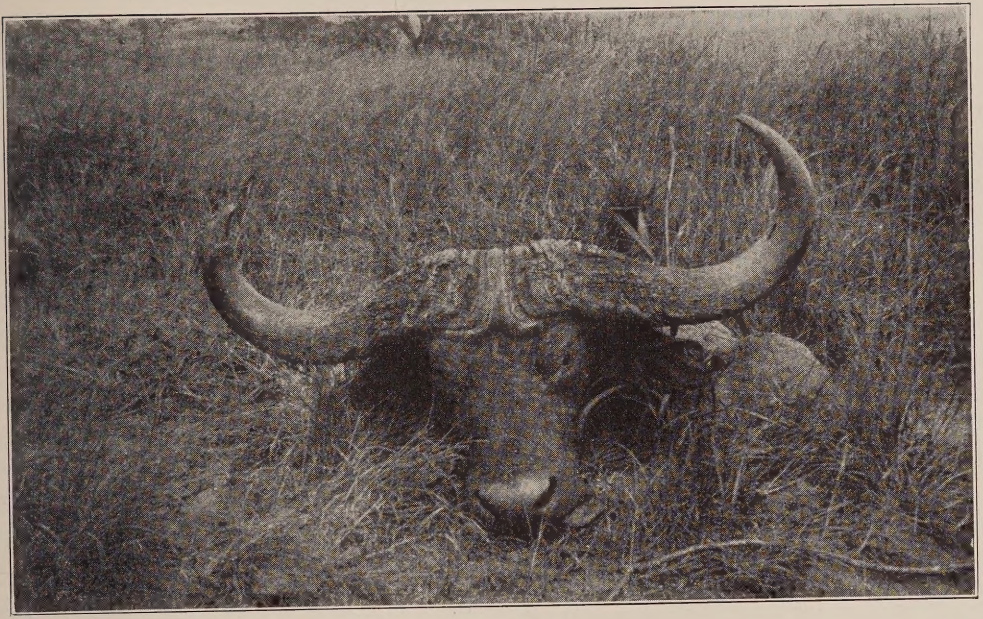
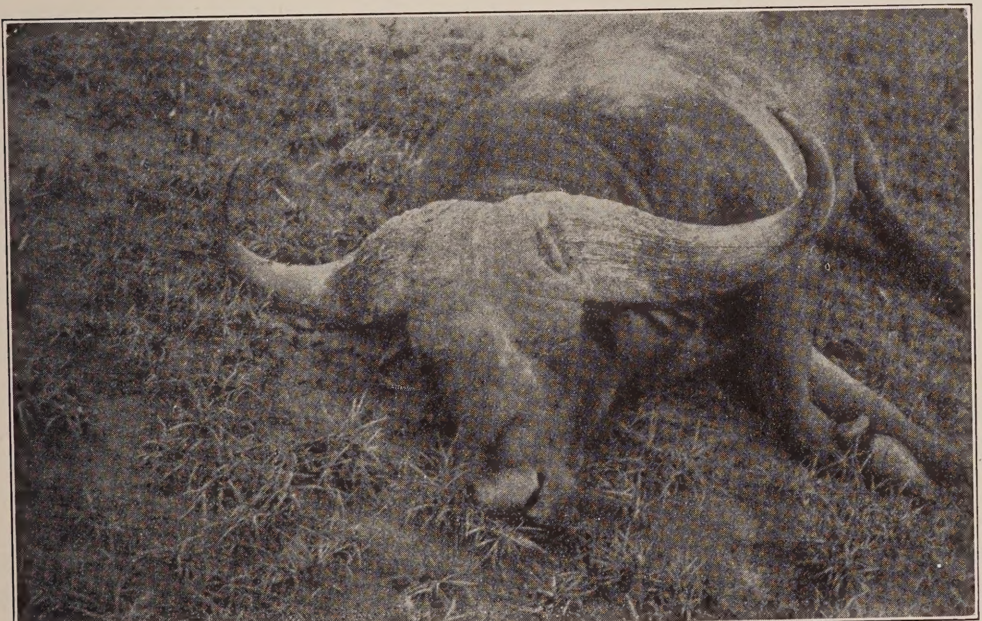
[1] Fox: Report Lab. of Museum of Comp. Path. of Zoological Society of Philadelphia (1929), p. 46.

[2] Stunkard: Bull. Amer. Museum Nat. Hist. (1929), LVIII, 233.





Nos. 364, 365. — *Bubalus caffer*

Neveu-Lemaire[1] notes that the wart hog (*P. africanus* and *P. aethiopicus*) can harbor the larva of *Porocephalus annulatus*, while Wenyon[2] notes the infection of *P. aethiopicus* with *Trypanosoma brucei*, *T. congolense* and *T. simiae* Bruce et al.

Buffalo, Bubalus caffer; Bubalus nanus. In eleven buffalo of the larger Cape type, *Bubalus caffer*, shot upon the plains of Lake Edward and upon which necropsies were performed, in seven a species of amphistome was found in the stomach or small intestine; in three others no observations were recorded regarding intestinal parasites, owing to unfortunate conditions such as darkness, distance from camp, etc., preventing a complete examination. In one animal it is stated that no intestinal parasites were found at the necropsy. However, it is realized that if very few parasites were present they might easily have escaped observation in some portion of the stomach or intestine. It seems probable that in this region of the Congo, infection of this type of buffalo with this amphistome is not only very frequent but perhaps almost universal.

The specimens of amphistomes were sent to Dr. Horace W. Stunkard, Director of the Biological Laboratory of New York University, who has kindly studied them and reports that the species is *Cotylophoron cotylophorum* (Fischoeder, 1901), Stiles and Goldberger, 1910. Stiles and Goldberger[3] in 1910 gave a description of the genus *Cotylophoron* and of twenty species. Stunkard[4] has recently in connection with the examination of material from the Belgian Congo, carefully described the species *Cotylophoron cotylophorum*, in material from the domestic cow and from the stomach of the antelope *Neotragus pygmaeus* and from the stomach of another antelope, *Adenota kob alurae.* This trematode, though it was more frequently found by us not free but attached to the mucous membrane of the intestine, apparently produces no lesions. No evidence of its having bored into the intestinal wall was found and no cysts were seen in the alimentary tract. Also, histological examination of sections of the intestine of the buffalo which harbored this parasite, shows that the mucous membrane is normal. In one instance, however, there has been an extensive postmortem invasion of the intestine by a fungus which was evidently present in the intestine at the time the animal was killed. Very numerous spores of this fungus are found on the surface of the mucosa of the intestine and extending in smaller numbers through the mucosa and into the submucosa. There is no cellular reaction upon the part of the host about the cells of the fungus and it seems quite evident that the invasion of the tissues occurred after the animal was shot and during the few hours that elapsed before the necropsy could be performed and the tissues placed in the preserving fluid. These animals often were shot long distances from camp and hence considerable time sometimes elapsed before the bearer with microscope and laboratory equipment could reach the locality.

A species of *Setaria*, subsequently identified as *S. labiato-papillosa*, was encountered in the abdominal cavity attached to the mesentery or omentum, or upon the surface of the liver in three of the buffalo. In many instances the worms were more or less calcified. The peritoneum appeared otherwise normal and the parasite has apparently no special pathological importance. Other hosts of the different species of *Setaria* are referred to on page 455. Thwaite [1] gives the following hosts for *Setaria labiato-papillosa.*

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[1] Neveu-Lemaire: Ann. Parasit. (1927), V, 368.

[2] Wenyon: *Loc. cit.*, p. 511.

[3] Stiles and Goldberger: Bull. Hyg. Lab. No. 60, U. S. Public Health and Marine Hosp. Service (1910).

[4] Stunkard: Bull. Amer. Museum of Nat. Hist. (1929), LVIII, 263.

Cattle
Cervus elephas
C. columbianus
C. virginianus
C. capreolus
C. rufus
C. nambi
C. simplicicornis
Capreolus caprea
Equus caballus..........(in the eye)
(?) *Bison americanus*
Bos caffer
Tragelaphus scriptus
Taurotragus derbianus

Bubalus nanus. In five buffalo of the smaller forest type (*Bubalus nanus*) shot in the glades in the Ituri Forest near New Beni, and including the marginal black, the pigmy black, and the marginal red buffalo, trematodes were found in very large numbers in the stomach or intestine of all. Although the infections were very severe, the sections of the intestines revealed no lesions. These amphistomes have been identified by Stunkard as *Cotylophoron cotylophorum.*

In addition, in the marginal red and marginal black buffalo, nematodes about 2.5 cm. in length and 3.4 mm. wide, were found in the first intestine. These were not found in the other forest buffalo or in the buffalo of the Cape type, *B. caffer.* In the pigmy black buffalo a few trematodes were found in the liver, particularly in the dilated bile ducts. Some half-dozen of the parasites were collected and preserved. The infection was apparently not severe, though the liver showed some areas of cloudy swelling or early fatty degeneration. The trematode from this buffalo has been identified by Sandground as *Fasciola hepatica.* Although this parasite gives rise to a severe and not infrequently a fatal infection in sheep, it is questionable whether the infections in the buffalo were sufficiently severe to make it of important pathological significance in this animal. A number of human infections with this parasite have been recorded. Croste [2] has recently reported a case in France in which the patient had anorexia, digestive disturbances, and diarrhoea, and an incision was made over the liver and into the bile duct for biliary obstruction. *Fasciola hepatica* was demonstrated in material from the duct. Sevenet and Champagne [3] have also published upon a third case of infection of man in Algeria with *Fasciola hepatica.* They in addition refer to two previous cases of infection in man in Algeria with this parasite which were previously reported by Maury and Pelissier and Desage. In two of the cases the diagnosis was made from the examination and finding of the ova in the stools and in the third the parasites were found at an operation on the gall ducts.

Patterson [4] has also described a case of human infection with *Fasciola hepatica* in which there were severe abdominal symptoms, colic and cough at times.

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[1] Thwaite: Ann. Trop. Med. and Hyg. (1928), XXI, 427.
[2] Croste: Ann. Parasit. Humaine et Comparée (1928), VI, 321.
[3] Sevenet and Champagne: Bull. Soc. Path. Exot. (1928), XXI, 222.
[4] Patterson: Lancet (1928), p. 1291.

There was also a leucocytosis of 18,000 and an eosinophilia of forty-two to sixty-two per cent. The patient was said to be cured by treatment with magnesium sulphate, increasing doses of hexamine with bicarbonate of soda, and intravenous injections of stibosan.

A herd of Ituri Forest buffalo suddenly charged toward us in high grass, and unfortunately in the rapid firing necessary to stop the charge two cows were killed, one a pigmy black and one a marginal black. These two cows were found to be pregnant and in the uterus of each was an apparently almost full-term calf. In each instance the hair of the foetus was jet black, like that of the mother. Mention is made of this fact because it has been stated by several zoologists and hunters that the newly-born calf of the marginal black type is red and that the hair turns black only in the older animal.

In one buffalo, an old animal, there were found at autopsy in the liver small grayish-white areas from pinhead to about 5 mm. in diameter. Upon aspiration with a small syringe they were apparently small cysts containing clear, very albuminous fluid which coagulated quickly in alcohol. They seemed to possess a distinct cyst wall. Microscopical examination of the contents did not reveal any parasites or ova. The portions of the liver containing the cysts (?) were preserved in Zenker's solution. Histological examination of these tissues shows that these circular spaces in the liver or cysts are lined with a thin membrane and that there is no cellular reaction whatever, inflammatory or otherwise, in the surrounding tissue. The surrounding liver cells appear perfectly normal. The cysts or sacs are empty. There is no evidence whatever that they are of parasitic or infectious origin.

In one of the buffalo two small fibroid tumors were found in the skin and in another a small abscess about 5 cm. in diameter on the back. The microscopical examination of the abscess showed both bacteria and fly larvae present in the abscess. The sections, however, show no fly larva, though both cocci and bacilli are present.

A large number of ticks, of tsetse, and other flies were also collected from a number of these animals. They are reported upon by Bequaert in the entomological section of this Report (Chapter XXXVI).

Of eight buffalo examined by Bruce, *Bubalus caffer*, the blood of one when injected into a dog was said to have caused infection with *Trypanosoma brucei*. Neveu-Lemaire [1] therefore, lists these animals as a reservoir of the virus of nagana in Zululand. We were unable to find trypanosomes or other parasites in the blood of the animals we shot.

In addition to the parasites of man already mentioned, that have been reported in *Bubalus*, the cysticercus of *Taenia saginata* [2] and *T. solium* and the "hydatid" of *Echinococcus granulosus* are to be included. Possibly the buffalo may also be a host of *Fasciola gigantica*.

Hippopotamus amphibius amphibius. In the examination of eight hippopotamuses which were shot in the Ruchuru Plains near the Ruchuru River and

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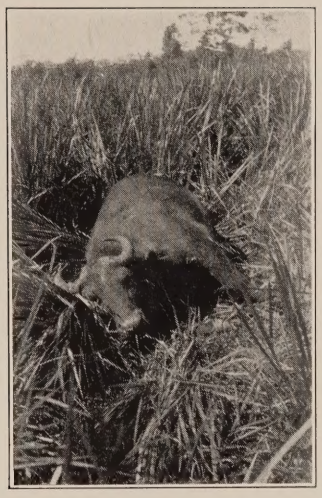
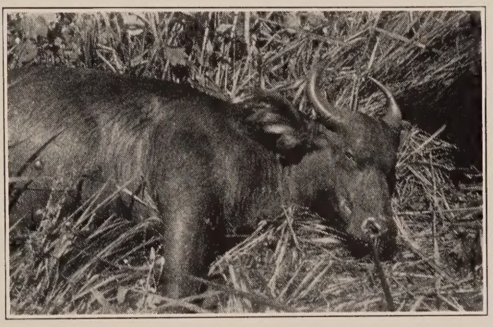
[1] Neveu-Lemaire: Ann. Parasit. Humaine et Comparée (1927), V, 150.

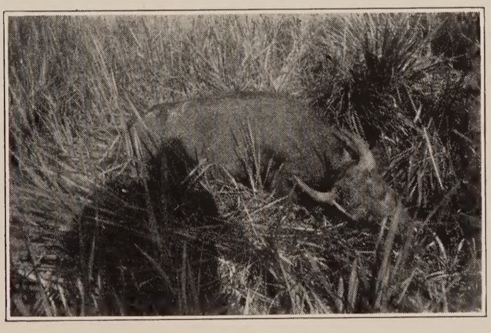
[2] Cameron: Proc. Royal Soc. Med. (1927), XX, 547.



No. 366. — Marginal black type



No. 367. — Pygmy black type



No. 368. — Pygmy red type
Bubalus nanus

on the shores of Lake Edward, nematode infections were found in seven. In five animals shot in the region of Lake Edward, nematodes were present in very large numbers in the intestine. They were especially numerous on the surface of the mucous membrane and less numerous in the faecal material in the intestine. In two animals, only the ova of these nematodes were found. These were shot near the Ruchuru River.

In one instance, trematodes were present in large numbers in the first stomach. At the time of the necropsy many ova of this trematode were already hatched and the miracidia were observed in the faeces. This trematode, which was found in a hippopotamus near Lake Edward, has been identified by Dr. Stunkard as *Paramphistomum gigantocotyle.* Dr. Stunkard states, with reference to this species, that the specific description of it is somewhat confused and Maplestone's statement (1923) concerning the lobulation of the testes is not entirely accurate. He further states that these organs are deeply lobed and may show the configuration reported by Maplestone, but not necessarily so.

In a study of other parasitic worms collected by the American Museum of Natural History Expedition to the Belgian Congo, 1909–1914, Stunkard [1] found two other species of *Paramphistomum.* The first of these, *P. cervi,* was present in the stomach of the water buck (*Kobus defassa*) at Garamba, in the stomach of the kob (*Adenota kob alurae*) at Faradje, and in the stomach of the reed buck (*Redunca bohor*); while the second, *P. explanatum,* was found in the stomach of the domestic cow in the Congo.

We secured sections from several portions of the stomach of the hippopotamus which we shot and which contained this trematode (*Paramphistomum gigantocotyle*). Examination of the sections shows that the mucous membrane of the stomach is perfectly normal. Apparently, therefore, *Paramphistomum gigantocotyle* is without special pathological significance for the hippopotamus.

One species of the family Paramphistomidae, *Amphistomum watsoni* Conyngham, 1904 (= *Watsonius watsoni* Stiles and Goldberger, 1910) has been reported in man. The patient was a negro from German West Africa who died in Northern Nigeria. The symptoms were persistent watery diarrhoea without blood or mucus. Parasites were also passed in the stools.

Fantham, Stephens and Theobald [2] state that this parasite has also been encountered in the caecum of the monkey, *Cercopithecus callitrichus* (Railliet, Henry et Joyeux,[3] 1912).

Gastrodiscus hominis (*Amphistomum hominis,* Lewis & McConnell, 1876) which has been placed in a new genus, *Gastrodiscoides,* by Leiper, has also been found in the caecum and colon of man, as well as in the pig in the Far East. In Annam it is especially frequent in the pig, where apparently no special pathological conditions have been noted.

The *nematodes* which we collected from these hippopotamuses consisted of two species which have been identified by Sandground. One of these is *Cobboldina*

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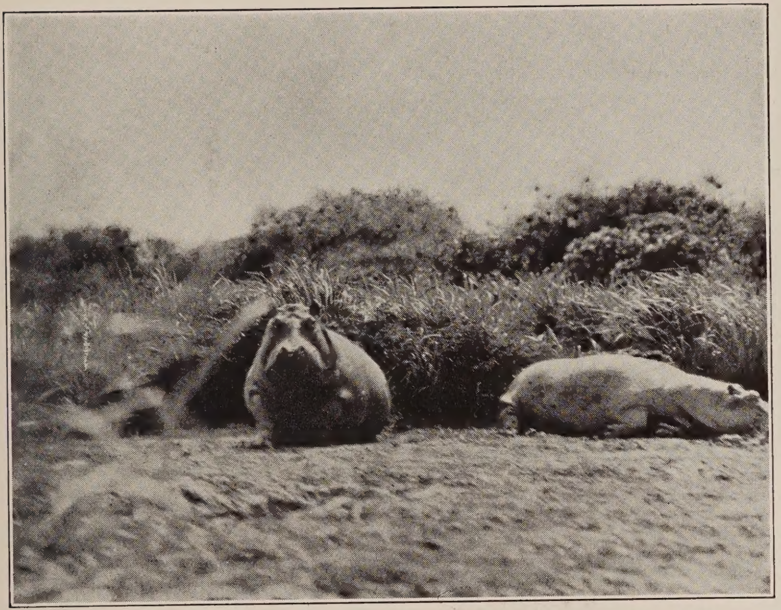
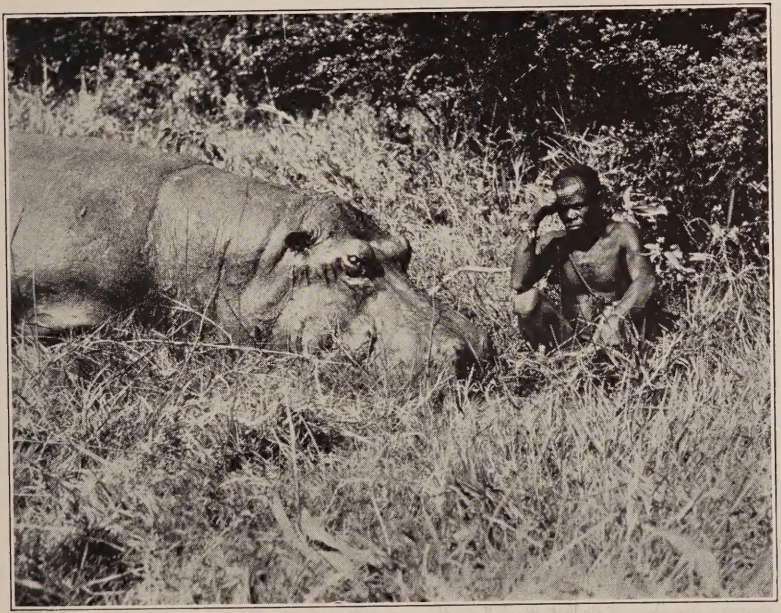
[1] Stunkard: *Loc. cit.*, p. 237.

[2] Fantham, Stephens and Theobald: *Loc. cit.*, p. 235.

[3] Brumpt: "Précis de Parasitologie" (1927), p. 507.





Nos. 369, 370. — Hippopotamuses (*H. amphibius*) at Kwakaniki and Ruchuru Plains, Lake Edward

Nos. 371, 372. — Hippopotamuses (*H. omohibius*) at Kwakaniki and Lake Edward

No. 373. — Necropsy upon hippopotamus

vivipara which was described by Leiper from the hippopotamus in 1910. The second nematode Sandground has described as *Leiperiatus hopkeni* (Leiper, 1910). This parasite was observed by Leiper in a hippopotamus shot in the Uganda and named previously by him, *Nematodirus hopkeni.* Sandground has redescribed this parasite, as Leiper's description of it was incomplete, and has found it necessary to create a new genus (*Leiperiatus*) for it (see page 465).

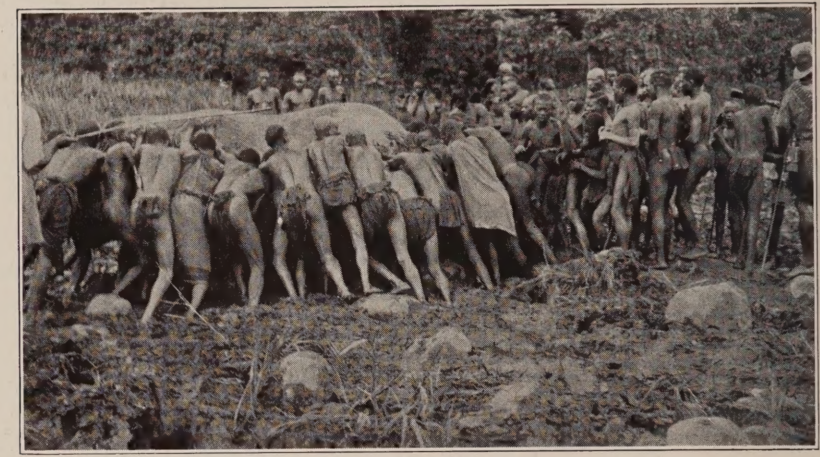
Stiles, 1926, does not list any species of *Nematodirus* (Ransom) as having been reported in man and only gives the habitat as the duodenum of ruminants.

A study of a number of sections of different parts of the small intestine of the hippopotamus in which severe infections with these nematodes occurred shows that no definite lesions of the intestine can be attributed to them. In one or two places there is slight catarrhal inflammation on the surface of the mucous membrane in which desquamated epithelial cells and a few leucocytes, together with bacilli, are seen, but no sections of the nematodes occur in this area and none are seen within the crypts of the villi. Neither of the nematodes, therefore, can be regarded as having especial pathological significance for the hippopotamus.

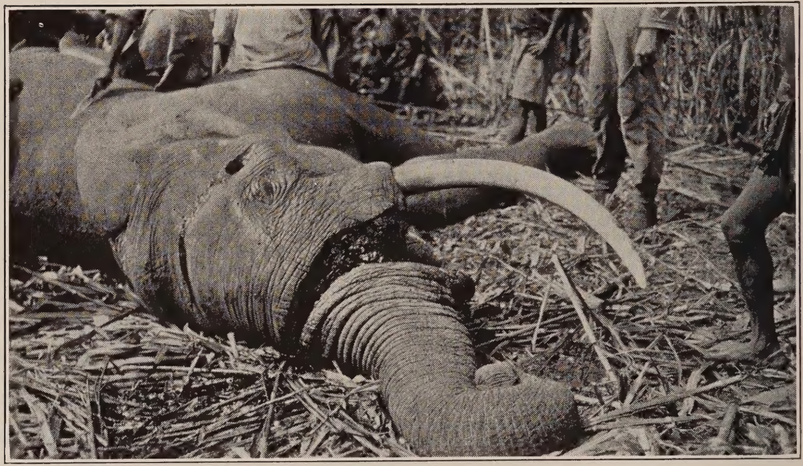
In the case of a hippopotamus shot at night, it was not practicable to perform the necropsy until the following morning at which time the carcass was found to have been considerably gnawed during the night by hyenas. The viscera then showed postmortem degeneration, particularly of the stomach walls and of the liver and spleen which were soft and friable. A general infection with *Bacillus aerogenes capsulatus* was present. This organism was found in large numbers in films from the heart's blood, spleen, and liver.

Flies and ectoparasites, ticks, and leeches were collected from the hippopotamuses. The specimens of ticks and leeches were apparently lost. Possibly the tick may have been *Hyalomma hippopotamense* Denny. The tabanids and oestrid fly collected are described in Chapter XXXVI.

Elephant: Loxodonta africana capensis. Considerable difficulty was usually encountered in connection with the performance of necropsies upon elephants in the field or jungle (Nos. 374–378). The animals often have to be tracked and followed on the trail through the forests and across streams for hours. Hence they are usually shot at long distances from camp, generally not less than at least three or four hours walking distance away. It is impossible to have the porter carrying the postmortem and laboratory equipment accompany one throughout the time spent in trailing the animal, as will be obvious to any African hunter. Hence, after the elephant has been shot, one's gun bearer must be sent to summon the native who carries such laboratory equipment, and all travel in these regions must be performed on foot. The necropsies usually have to be carried out in the hot sun and they sometimes require between four to five hours to complete on account of the great size of the animals. Almost invariably, also, there is a crowd of several hundred natives surrounding the animal and fighting among themselves for the meat. Considerable activity and care is necessary in order to prevent the natives from carrying off the viscera or parts of the viscera before they have been examined and sections and microscopic preparations made.

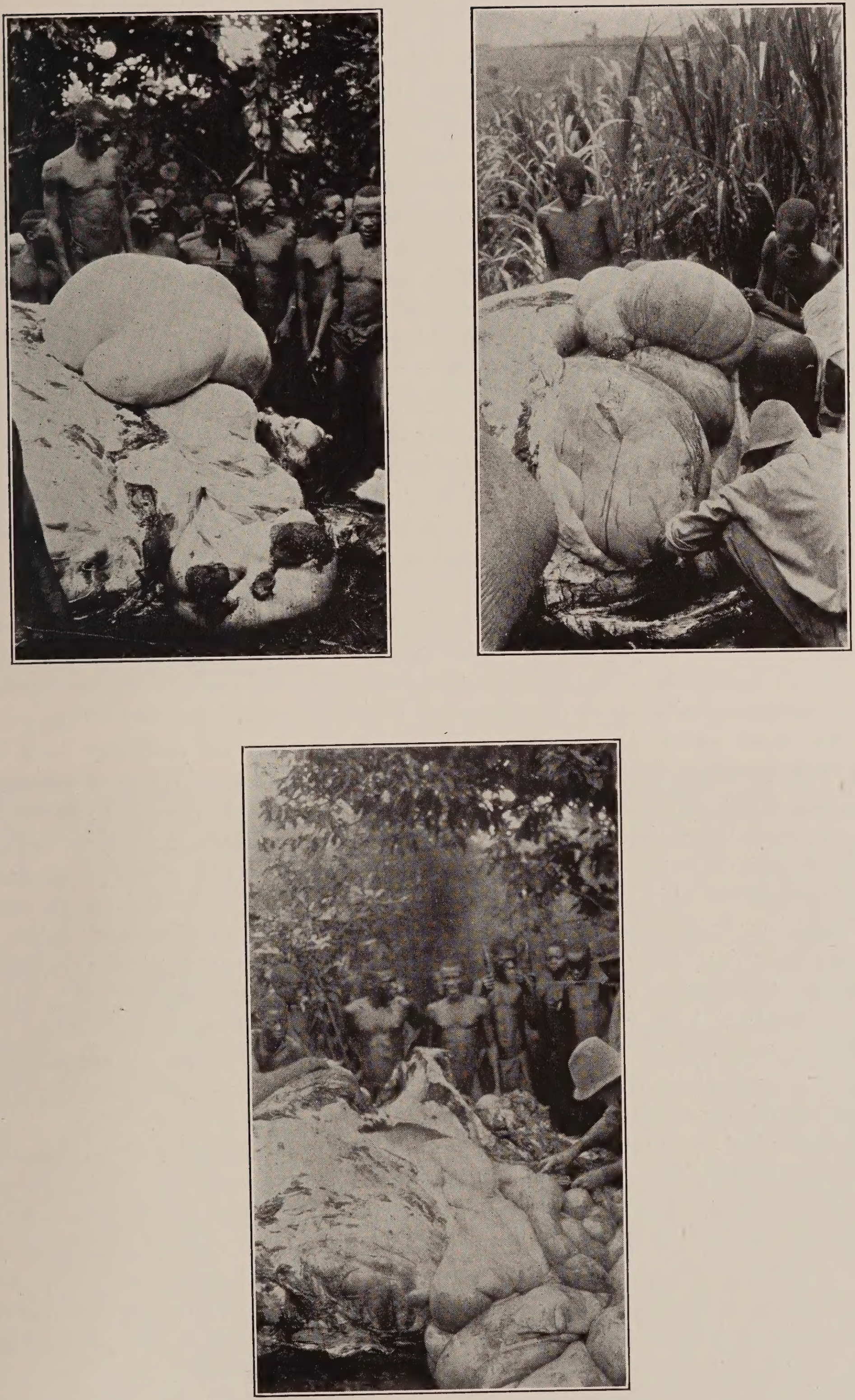


No. 374. — Turning of the body



No. 375. — Beginning of necropsy

Necropsies upon elephants, *Loxodonta africana capensis*



Nos. 376, 377, 378. — Exposure of stomach, intestines, and other viscera

In five elephants shot in the Belgian Congo, south of New Beni, in the Semliki Valley and in the Ituri Forest, upon which necropsies were performed, in all large numbers of two species of larvae of flies (Cobboldiinae) were found in the stomach. Bequaert has identified these species as *Cobboldia loxodontis* (Brauer) and *Rodhainomyia chrysidiformis* (Rodhain and Bequaert). Large numbers of nematodes of the genus *Murshidia* were also found in the intestines of these animals. Some twenty species of the genus *Murshidia* have been described from elephants, both African and Indian, as well as the rhinoceros. Khalil [1] says that the parasites found in the African and Indian elephants never belong to the same species. Several authors have divided the genus *Murshidia* into six genera.[2] However, Yorke and Maplestone [3] after working through the large collections of the Liverpool School of Tropical Medicine of worms from the elephant and rhinoceros, have reached the conclusion that the genera *Pteridopharynx* Lane, 1914, *Memphisia* Khalil, 1922 and *Henryella* Neveu-Lemaire, 1924, are synonymous of *Murshidia* Lane, 1914. In view of the apparent absence of a mouth collar in *Buissonia,* however, they propose to leave this genus pending further investigation. The species represented in our collection of *Murshidia* have not yet been identified by Sandground.

From a histological study of the sections of the intestine and stomach of the elephants, it does not appear that either the *Cobboldia* or the *Murshidia* cause any important lesions since the mucous membrane of these regions appears normal in the sections studied. In one elephant, however, which was shot toward sunset and upon which it was not practicable to perform the necropsy until the following morning, the sections of the intestine and spleen show very extensive invasion of a fungus, mycelium and spores being found in all parts of them.

In one elephant there were very numerous small nodules in the skin, each of which contained in the center the larva of a fly. These tumors were particularly abundant in the skin over the buttocks and hind legs, and consisted of small swellings 5 to 8 mm. in diameter. A number of them were excised and placed in Zenker's solution, formalin and alcohol. Some of the larvae of the flies that were expressed from the tumors were also placed in the same preservatives. These larvae also have been recently encountered by Rodhain,[4] who has identified the fly as *Ruttenia loxodontis.* Number 387, illustrates the larva of one of these flies lying partially in the corium of the skin. As may be seen from the drawing, there is marked infiltration about the lower portion of the larva.

In the elephant's skin, the papillae are very prominent and of considerable height. The stratum corneum, with the stratum mucosum, dips down deeply into the corium. It is particularly in these folds as well as in the pores of the skin that the young larvae come to rest. Evidently the oval larva then, as it develops in size and particularly in length, is not able to escape from the narrow orifice of the pore of the skin above. Hence, it pushes the epidermis downward into the corium for a distance sometimes of nearly a centimeter, producing a

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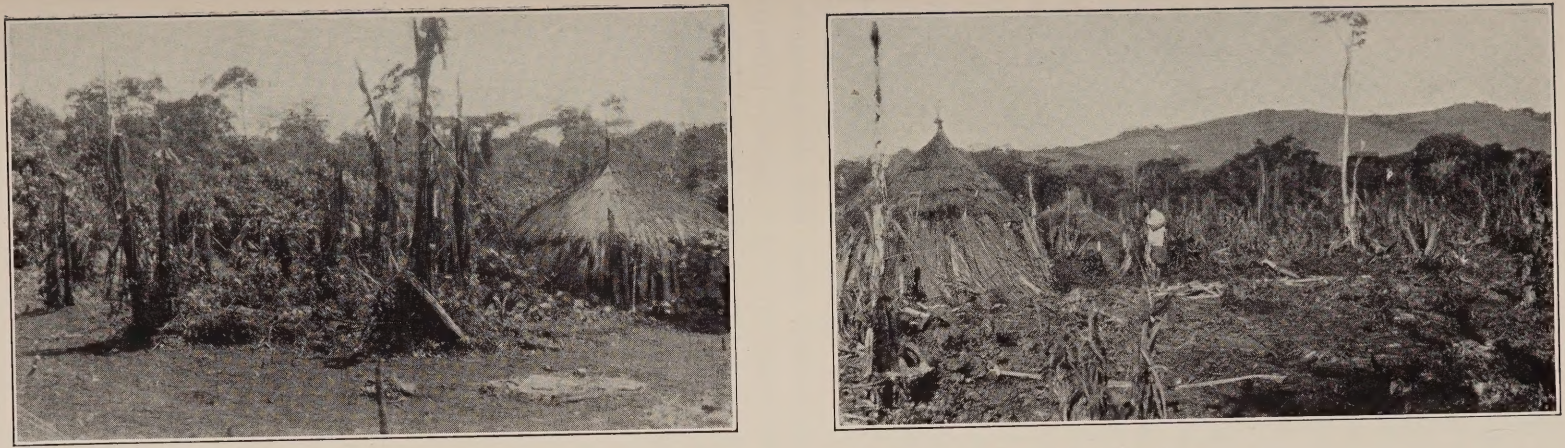
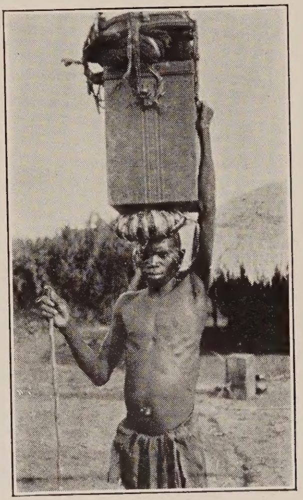
[1] Khalil: Proc. Zool. Soc. of London (1922), p. 205.
[2] Mönnig: Trans. Royal Soc. of South Africa (1925–1926), XIII, 313.
[3] Yorke and Maplestone: "Nematode Parasites of Vertebrates" (1926), p. 81.
[4] Rodhain: Ann. de Parasit. Humaine et Comparée (1927), V, 198.



Nos. 379, 380. — Destruction of villages and banana plantations by elephants
(No. 380 illustrates village after passage of elephant herd)

No. 381. — Laboratory equipment



No. 382. — Microscope en route

furrow or cavity. In cross-sections of one of these areas the larva is usually seen to be surrounded by a rim of epithelium except at one point near the head where the mouth parts have apparently pierced for nourishment. In these areas there is marked infiltration of the corium with round cells and leucocytes. In other parts of the epithelial wall enclosing the larva there may be extensive cellular infiltration of the corneal and mucous layers of the skin. The mucous layer itself may be proliferated and considerably thickened, particularly at the lower end of the cavity formed by the developing larva. To judge from the cellular reaction in the corium and the hypertrophy of the epithelium, one might suppose that the parasite would occasion considerable inconvenience to an animal with at least a more highly organized nervous system than an elephant.[1]

In this same elephant there was an abscess about 5 cm. in diameter near the base of the right tusk from which pus exuded. Microscopical examination showed the ulcer to be of a bacterial nature and this was confirmed by the study of sections of the tissue. It seems entirely possible, however, that the site of this abscess might have been primarily the seat of invasion by the fly larva (*Ruttenia*), the lesions having become secondarily infected with bacteria.

The liver of this elephant was also not entirely normal. Sections of it show that in certain lobules and more toward the center of the lobules the liver cells are filled with a large amount of granular bile pigment. There are also evidences of healed central necrosis of the lobules with some regeneration of a number of the liver cells. In places the hepatic cells are pushed apart and the sinusoids filled with red blood corpuscles. There is a moderate amount of chronic passive congestion. These healed lesions perhaps represent some earlier infection during the many years of the animal's life. (The elephant was a full-grown male, eleven feet, three inches in height, and with massive tusks.)

It is of some interest to note that *Fasciola hepatica* as well as *Echinococcus granulosus* have been reported from the livers of Asiatic elephants.[2]

Blood examinations were made of all the elephants, as well as in the case of all the wild game shot, but no trypanosomes or other parasites were found in the blood. The flies and ecto-parasites collected from elephants are referred to by Bequaert (Chapter XXXVI).

Antelope (*Cobus; Cervicapra; Tragelaphus*). Examination of the blood of antelopes shot for food was made, particularly with reference to the presence of trypanosomes. The commonest of them was *Cobus thomasii*. However, the large water buck, *Cobus defassa*, reed buck, *Cervicapra arundinum*, and bush buck, *Tragelaphus scriptus*, were also often shot and examined for parasitic infection. In none of the antelopes we examined in the Ruchuru and Ruindi plains were parasites encountered in the blood. The only parasitic infection found in *Cobus thomasii* was an occasional mild abdominal infection with *Setaria hornbyi* which gave rise to no visible disturbance. This parasite apparently is recorded for the first time from this animal. The antelopes appeared to be

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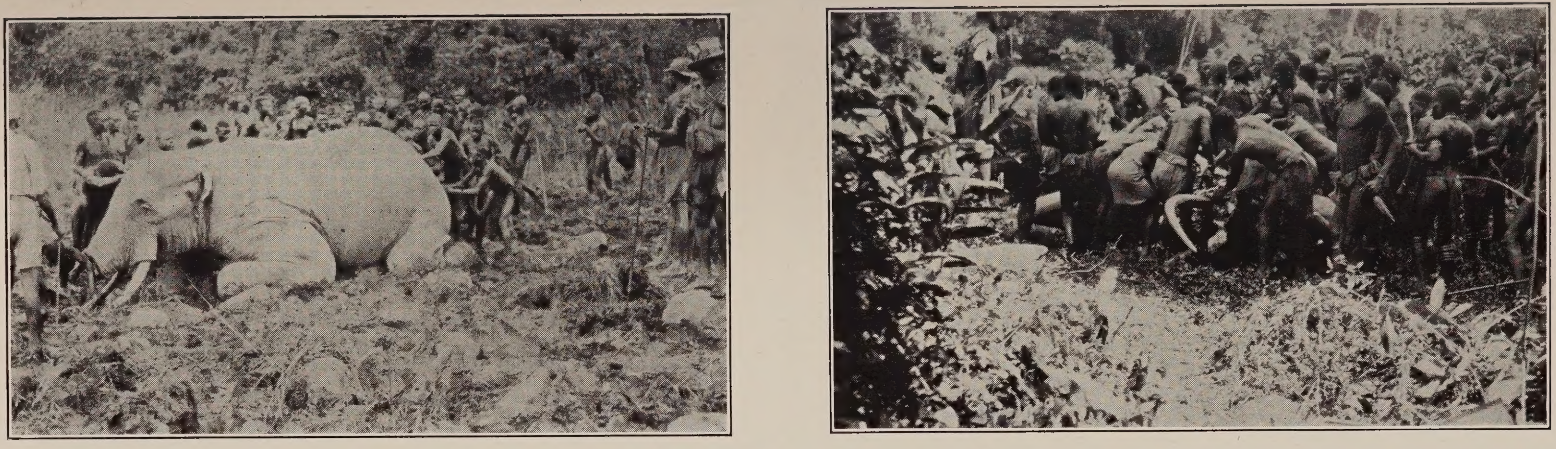
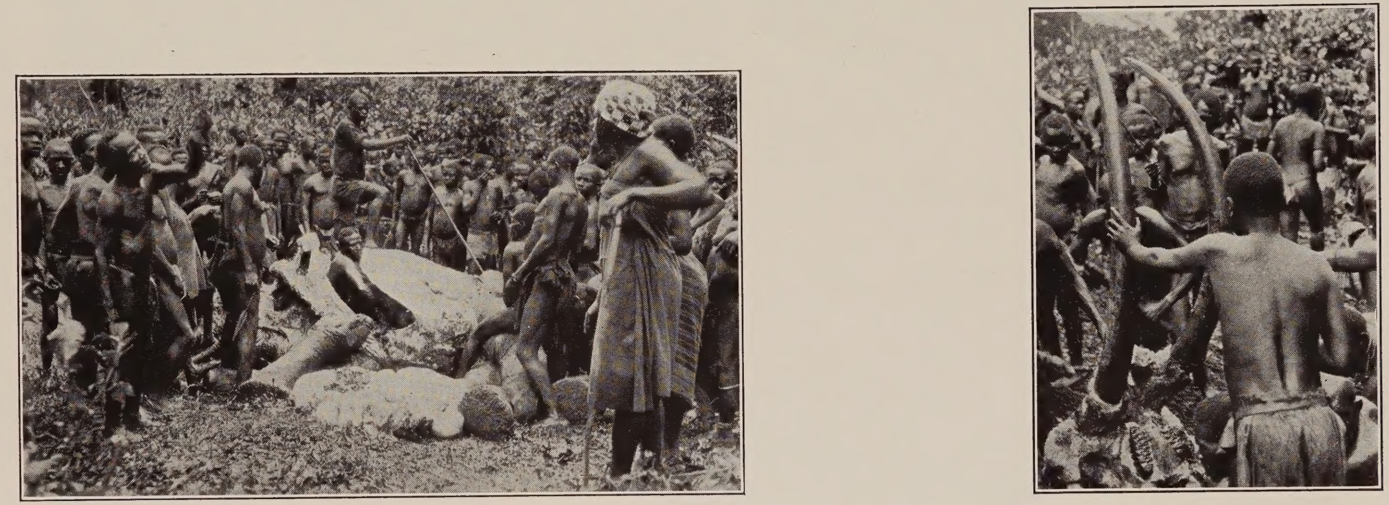
[1] Another of these oestrid or bot-like flies was encountered in the nostrils of one of the hippopotamuses, which has also been identified by Bequaert as *Rhinoestrus hippotami* (page 975).

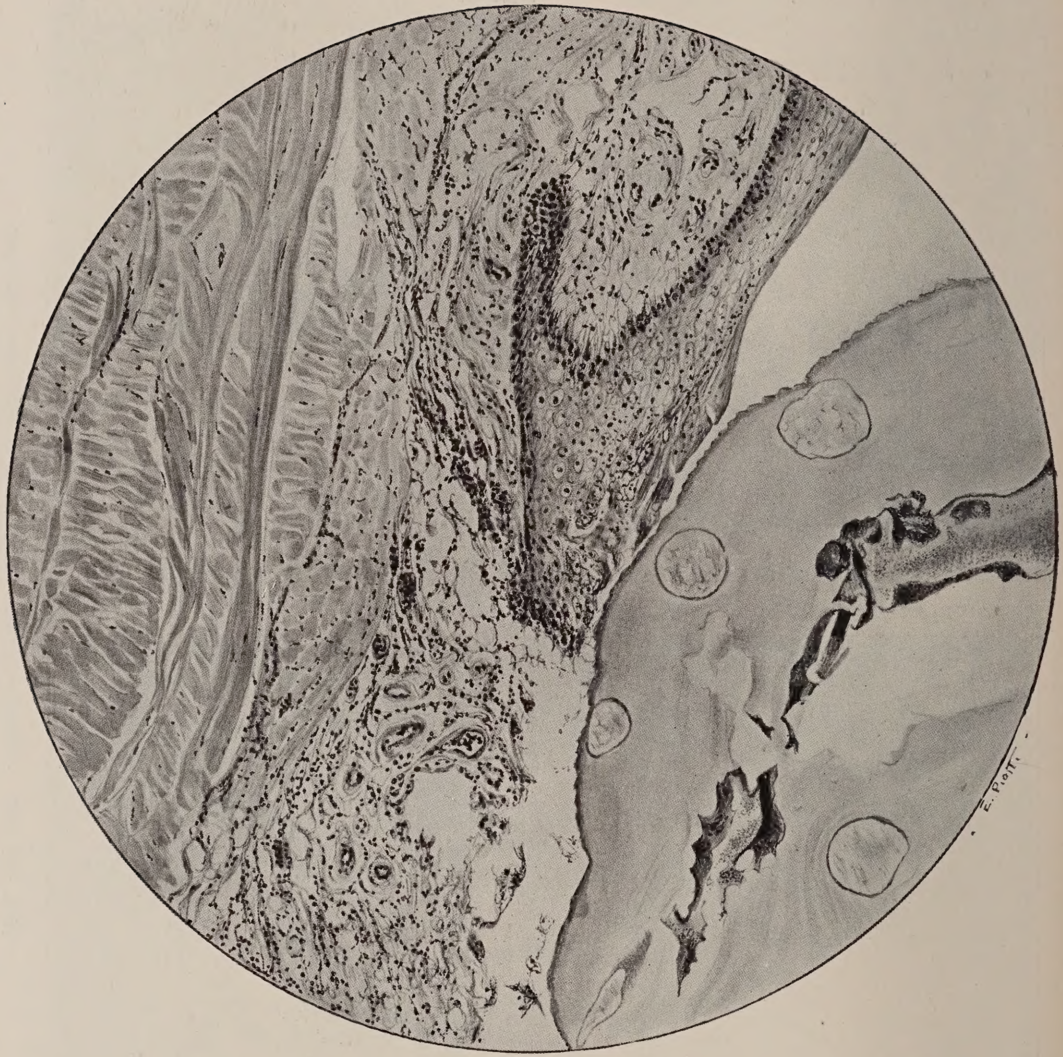
[2] Neveu-Lemaire: *Loc. cit.*, p. 371.



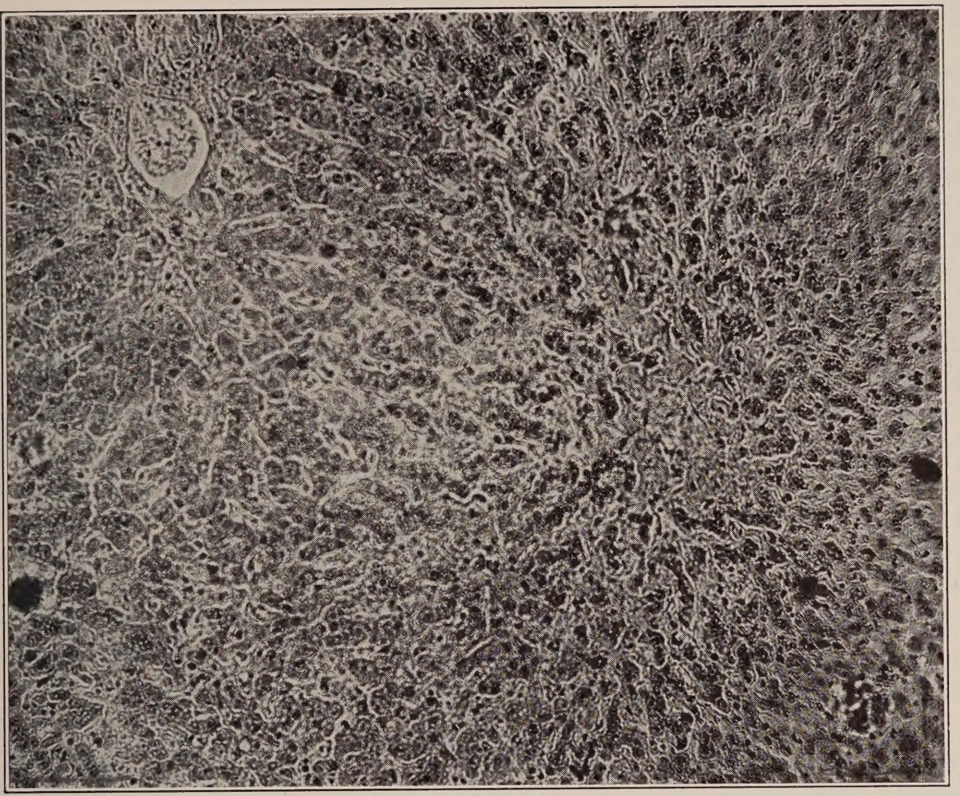
Nos. 383, 384. — Necropsies on elephants

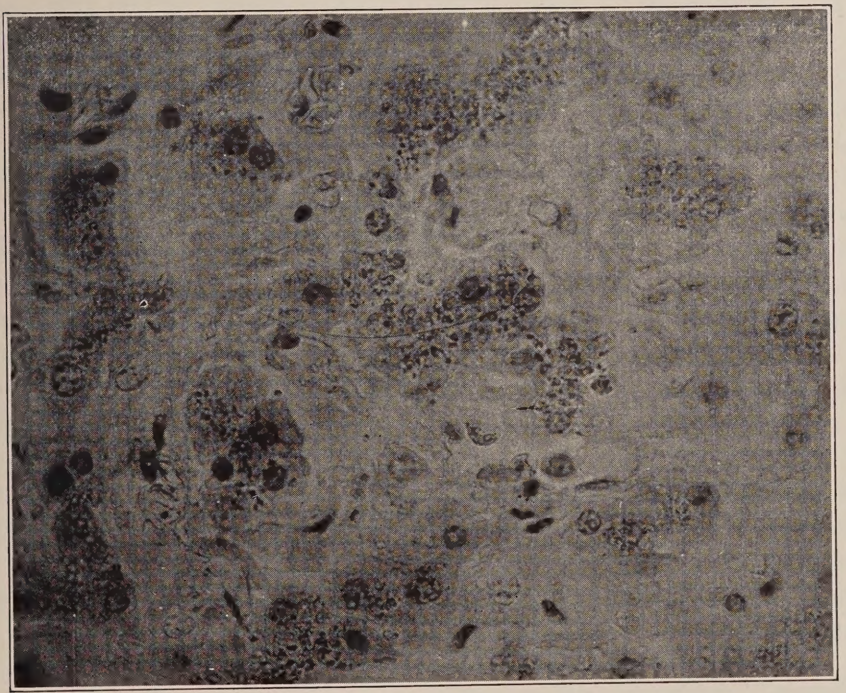


Nos. 385, 386. — Division of meat and removal of tusks after necropsy



No. 387. — Drawing of a section of the larva of the fly, *Ruttenia loxodontis*, in the elephant skin, with inflammatory reaction in the corium





Nos. 388, 389. — Photomicrographs of chronic passive congestion and necrosis of the liver in Elephant 4. Zeiss objective AA, and objective DD, compensating ocular 6 especially healthy. In the bush buck (*Tragelaphus scriptus*) an amphistome was found which Stunkard identified as *Cotylophoron cotylophorum.* This parasite was also encountered by us in *Bos taurus* and in *Bubalus caffer* and *nanus.* Although no trypanosomes were found in the antelopes, numerous tsetse flies (*Glossinae*) were collected from many of the animals which were shot on these plains and in the Ituri Forest and the southern Semliki Valley. It is usually stated that the most common animal host for *Trypanosoma gambiense* is the sitatunga, *Tragelaphus* (= *Limnotragus*) *spekei* of which naturally infected animals have been found in earlier years by Bruce and more recently by Duke. Bruce also showed in one instance that the blood of the harnessed antelope, *Tragelaphus scriptus* could transmit *Trypanosoma brucei* to an inoculated animal. The three species of antelopes which have been regarded as reservoir hosts of *T. rhodesiense* are the water buck (*Cobus ellipsiprymnus*), the reed buck (*Cervicapra arundinum*), and the common duiker (*Cephalophus grimmii*). Wenyon [1] has given a complete list of the game animals which may serve as reservoirs for the trypanosomes of man and domestic animals in Africa and the name of the investigator who has made the observation concerning the animal. To what extent the wild game in the eastern Belgian Congo is infected with trypanosomes pathogenic for man evidently is not known.

Dr. Van Hoof [2] of the League of Nations Commission on Human Trypanosomiasis, in his recent survey of the sleeping sickness situation in the southern Semliki Valley, travelled in the Belgian Congo from New Beni to Irumu. While he states that he found elephants, red buffalo, bush buck, hippopotamuses, and wart hogs numerous, he does not refer to the presence of trypanosomes in the game in this region. He points out, however, in connection with the absence of crocodiles in the southern part of the valley, that the game evidently plays a part in the biology of *Glossinae,* and that from this point of view, the absence of reptiles which elsewhere constitute a considerable item in the food of the flies, is an important factor. *Glossinae* were found to be plentiful by him and a number were dissected, but no flagellates were encountered. However, a number of cases of sleeping sickness in man were observed by Van Hoof and his associate, in this region. The trypanosomes they obtained from these cases were not successfully inoculated into laboratory animals, guinea pigs and monkeys.

Weck [3] has made observations upon the trypanosomes that he encountered in wild game in the region of Rovuma River, East Africa. He found water buck, reed buck, bush buck, and eland (antelope) occasionally infected with trypanosomes. He believes that all trypanosomes of wild game which cannot be successfully inoculated into monkeys can be excluded as being human trypanosomes. He also was unable to find any trypanosome in wild game which he could regard as identical with the human trypanosome, *T. rhodesiense,* and was unable to infect monkeys by *Glossina* which harbored trypanosomes in these regions.

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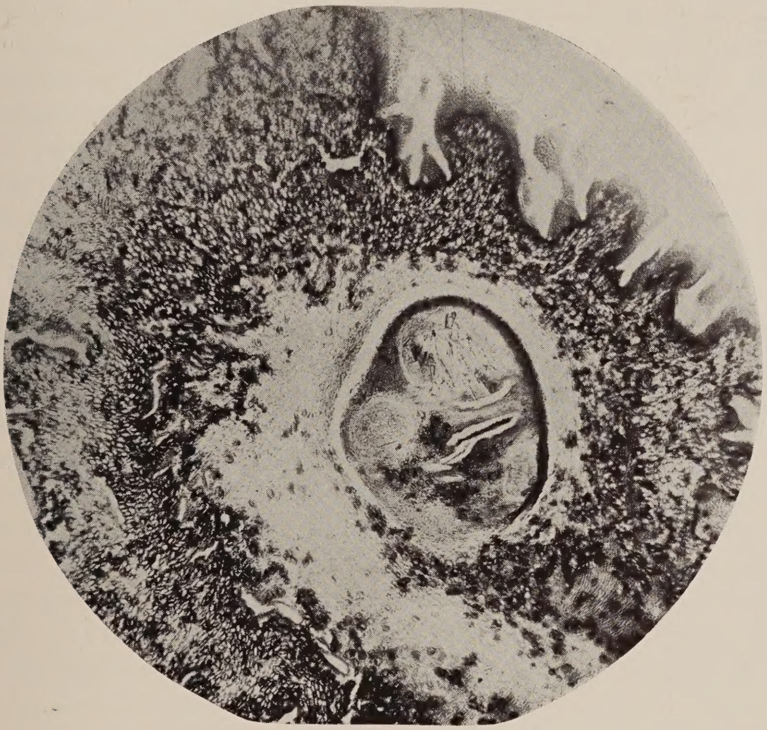
[1] Wenyon: "Protozoology" (1926), I, 510.

[2] Van Hoof: Final Report of the League of Nations International Commission on Human Trypanosomiasis. Geneva (1928), p. 329.

[3] Weck: Arch. f. Schiffs-u. Tropen-Hyg. (1914), XVIII, 113.

Buchanan[1] has also investigated the condition of wild game in the Rukwa Valley in the Ufipa district of Tanganyika Territory, badly infected with *Glossina morsitans*. Of the nineteen varieties of game examined, only the following were found to be infected with trypanosomes: water buck, impala, topi, zebra, eland, bush buck, giraffe, and puku, (thirty-one animals in all). Over fifty percent of the water buck examined harbored trypanosomes, while the other animals were seldom infected. He regards the organism as probably *T. brucei*, but he remarks that while the infection of wild game may be a significant factor in the transmission of the disease to human beings, its importance can only be computed when the identity of the trypanosomes and their pathogenic relationships are proved.



No. 390. — Photomicrograph, scolex in cyst of *Taenia pisiformis*, liver of topi, *Damaliscus corrigum jimela*

Topi (*Damaliscus corrigum jimela*). In necropsies performed in the Ruindi Plains upon twelve topi (the bastard hartebeest), *Setaria poultoni* Thwaite, 1928, was found in the peritoneal cavity in nine, while in two no note regarding the occurrence of this parasite was made.

In two of the twelve topi there were also found larval forms of a tapeworm (*Taenia pisiformis*) encysted in the liver and omentum. In one of the animals the cyst in the liver measured about 1 cm. in diameter, with four very slightly smaller adventitious cysts in the mesentery. In the second animal several cysts in the liver measured about 8 mm. in diameter. Eight other cysts were observed in the omentum of this animal. On section and microscopical examination of a number of the cysts a single scolex measuring about 1.5 to 2.5 mm. in diameter was found in each cyst. Portions of the cysts and a number of the parasites themselves were preserved in alcohol.

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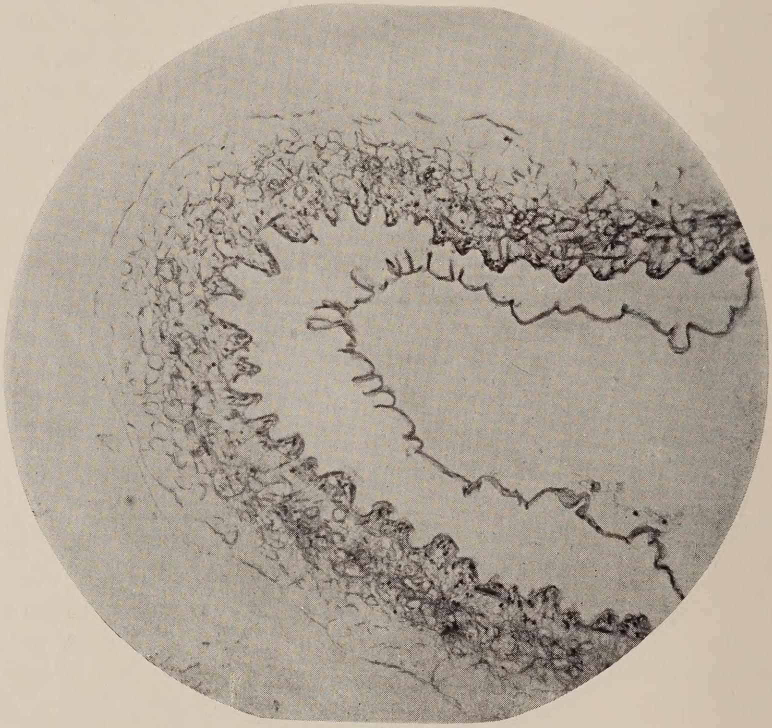
[1] Buchanan: Jour. Trop. Med. and Hyg. (1929), XXXII, 330.

Histological study of the cysts and tissues about them show that the cyst is enclosed in a thin fibrous capsule in which there is marked infiltration with round cells and a few leucocytes. Among the infiltrating cells eosinophils are present in small numbers. Within this capsule is a layer or zone of delicate vacuolated reticulated tissue which is not rich in nuclei. This layer of tissue is finally lined with an undulating, wavy membrane in which there are numerous closely placed filamentous papillae. This papilliform layer obviously constitutes the invaginating membrane. In a few places near or at the end of it may be seen the larval scolex. In other cysts where calcification has begun and perhaps where the death of the scolex has occurred, large numbers of lenticular or elliptical calcified corpuscles may be observed in the tissue which previously was evidently similar in structure to the delicate vacuolated areola tissue already referred to. The appearance of the undulating papilliform layer suggests that it may have the power of absorption of nourishment for the developing scolex.



No. 391. — Photomicrograph of cyst wall of *Taenia pisiformis*

Sandground, after clearing in lactophenol some of these cysts which were somewhat calcified, found that the scolex was provided with four muscular suckers, 250μ in diameter; forty-four hooks were mounted in two alternating rows on the rostellum. After comparing details in these specimens with those of a scolex of *Taenia pisiformis* from the dog, he believes that the cysticercus encountered in these topis conforms well enough with this species tentatively to be taken as its larval form. *Taenia pisiformis* has been recorded from both the lion and the leopard which prey upon topi in the locality where we secured this material.

Cysticercus pisiformis has been found previously in the peritoneal cavity of rabbits (*Lepus cuniculus*), hares (*L. timidus, L. variabilis*) and mice (*Mus musculus*). Vital[1] reported that he had observed *Taenia pisiformis* twice in the intestine of human beings. However, Galli-Valerio swallowed five specimens of *Cysticercus pisiformis* without any evidences of infection. Stiles[2] in his Key-Catalogue of the Worms reported for Man says the reported presence of this parasite in man is subject to confirmation.

The filariae (*Setaria poultoni* Thwaite) which we encountered in the topi were found upon the surface of the liver or in the folds of the mesentery or omentum. Many of them were partially calcified. Thwaite[3] has recently made an extensive study of the genus *Setaria*. He points out that species of *Setaria* have been found in a number of species of wild game in East Africa, such as the buffalo (*Bos caffer*), bush buck (*Tragelaphus scriptus*), eland (*Taurotragus derbianus*), water buck (*Cobus ellipsiprymnus*), impala (*Aepyceros melampus*), reed buck (*Cervicapra arundinum* and *C. fulvorufula*), puku (*Cobus vardoni*), topi (*Damaliscus corrigum jimela*), hartebeeste (*Bubalis lelwel jacksoni*), kob (*Cobus thomasi*), oribi (*Oribia oribi*), duiker (*Cephalophus* sp.), and klipspringer (*Oreotragus oreotragus*), as well as in the horse, donkey and ox. He lists fourteen other species of *Setaria* and also gives eight additional species concerning which knowledge is not definite. Nothing is stated about the pathological significance of the parasites. From our observations upon infected topi, buffalo and antelope in Africa, and upon cattle in the Philippine Islands, *Setaria* apparently does not give rise to any serious pathological condition.

Thwaite describes *Setaria poultoni* as a new species, he having collected and studied one female from the kongoni *Bubalis lelwel jacksoni* and four females and one male from the topi *Damaliscus corrigum jimela*. He points out that by reason of the four smaller lips and the deep depression into which the vulva opens, this worm can be easily distinguished from any species of the genus *Setaria* previously described. Our observations are apparently the second regarding the infection of this parasite in the topi, and they indicate that the infection may be, in some localities at least, of very frequent occurrence in this animal. While *Setaria equina* (?) infection in man has been reported in several instances,[4] Stiles[5] (1926) states that its presence in man has been questioned.

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[1] Vital: Fantham, Stephens and Theobald: "Animal Parasites of Man" (1916), p. 338.

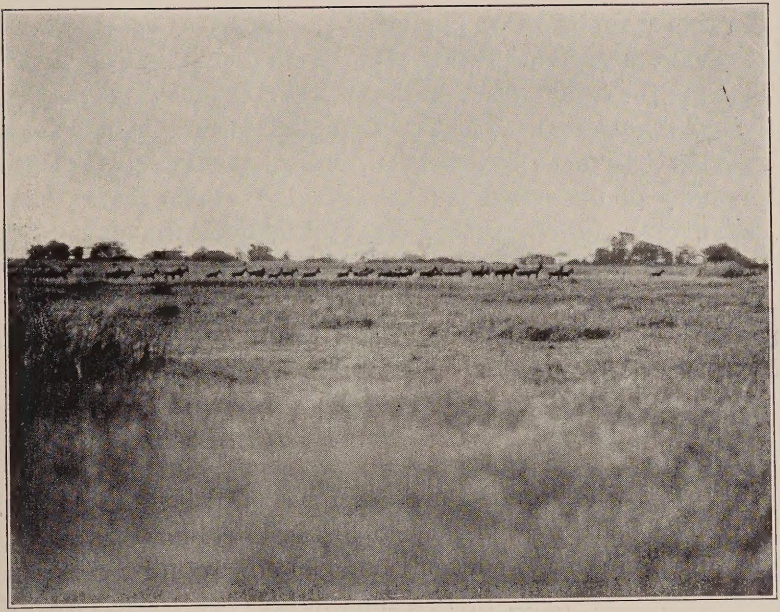
[2] Stiles: U. S. Hyg. Lab. Bull. No. 142 (1926), p. 111.

[3] Thwaite: *Loc. cit.*, p. 435.

[4] Fantham, Stephens, and Theobald: "Animal Parasites of Man" (1916), p. 408.

[5] Stiles: U. S. Hyg. Lab. Bull. No. 142 (1926), p. 147.

Nos. 392, 393. — Water buck, *Cobus defassa*



No. 394. — Topi, *Damaliscus corrigum jimela*

No. 395. — Wart hog, *Phacochoerus africanus*

Leopard, Felis pardus. In a leopard, *Felis pardus*, shot in the eastern Belgian Congo, the nymphs of a linguatulid *Armillifer moniliformis* Sambon,[1] 1922, *Porocephalus armillatus* Stiles 1908, were found in the liver. Sambon gives as hosts for the adult form, Indian python (*Python molurus*), reticulated python (*Python reticulatus*). For the nymphal form: man (*Homo sapiens*), macaque monkey (*Macacus cynomolgus*), rhesus monkey (*Macacus rhesus*), a Sumatran monkey of undetermined species, tiger (*Felis tigris*), leopard (*Felis pardus*), Indian civet (*Viverricula malaccensis*), domestic dog (*Canis familiaris*), Indian otter (*Lutra nair*). Sambon has reported sixteen cases of infection of man with the nymphal form of this parasite.

Railliet mentions the leopard as one of the definitive hosts of the human parasite *Echinococcus granulosus*, and Braun calls attention to the fact that it may harbor *Diphyllobothrium latum*. Neveu-Lemaire [2] says that the leopard is also probably a host of *Paragonimus ringeri* in India, and may be capable of harboring *Dracunculus medinensis*.

In another leopard shot by a native near Yakusu, the autopsy material of which was secured through the kindness of Dr. Chesterman, the stomach and small intestine contained numerous nodular areas measuring from about 1 to 3 cm. in diameter, lying in the submucosa, the mucosa and underlying tissues being pushed upward into the lumen of the intestine. Sections of these nodules revealed the presence of encysted parasites. In some instances a small opening in the mucous membrane communicated with the interior of the nodule or cavity in which the parasites were visible, but in other instances the mucosa appeared to be still intact over the nodule.

Histological study of the sections shows that the nodules lie in the submucosa. The epithelium above becomes increasingly thinned as one approaches the area of submucosa in which the nodules are situated, and in some areas over the center of the nodule the epithelium has entirely disappeared. In some sections the surface of the nodule is covered still by the muscularis mucosae; in other instances this layer has also disappeared. Many of the epithelial cells are degenerating and desquamated. In the submucosa there is a very dense cellular infiltration, particularly of lymphocytes and plasma cells. In other portions of the tissue there are small areas of necrosis with a deposition of fibrin and many degenerating polymorphonuclear leucocytes. In the central portion of the nodules are observed transverse sections of the nematodes. Outside the more acute areas of infiltration the tissue is more fibrous in character, with small islands of infiltrating cells.

The nematode encountered in these lesions has been identified by Sandground as *Gnathostoma spinigerum* Owen, 1836. The length of the male parasite is about 5 mm., while the female is approximately twice as long. This parasite has been reported previously in the stomach or intestine of the wild cat *Felis catus*, the puma *Felis concolor*, the tiger *Felis tigris*, and the domestic cat (India). Leiper considers *Gnathostoma siamense* to be identical with *Gnath-*

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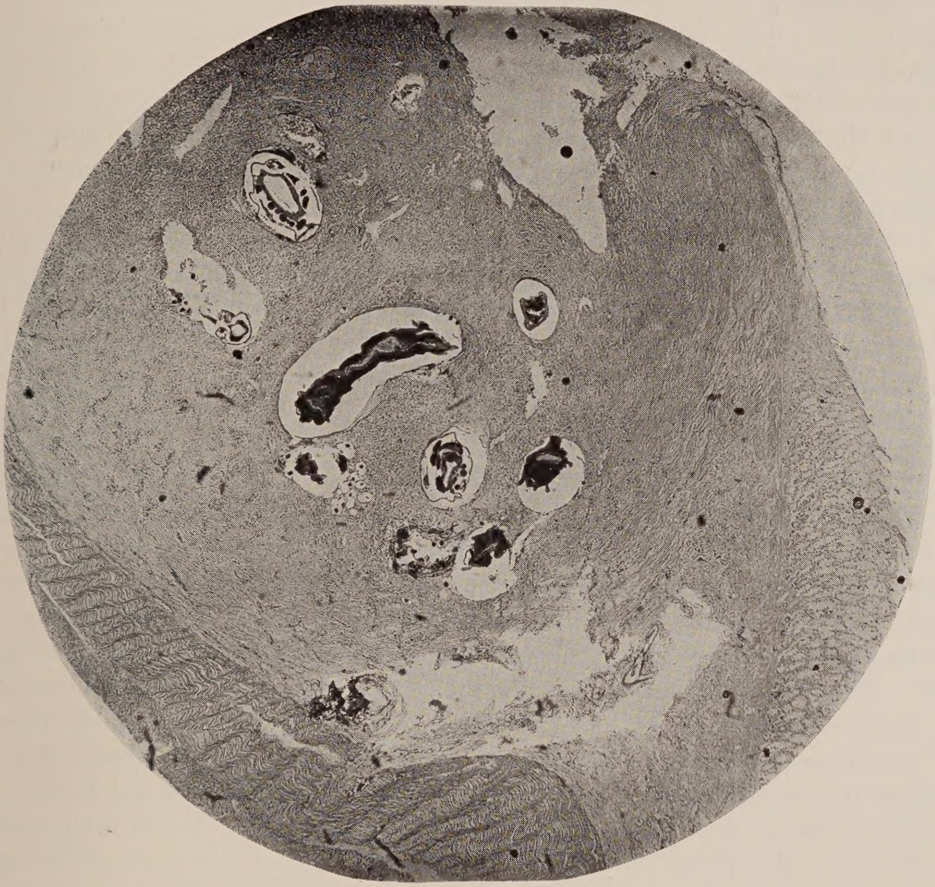
[1] Sambon: Jour. Trop. Med. and Hyg. (1922), XXV, 202.

[2] Neveu-Lemaire: Ann. de Parasitologie (1927), V, 377.

ostoma spinigerum siamense. A single specimen of the parasite described by Levinsen[1] was found by Deuntzer in Bangkok, Siam, and was obtained from a young Siamese woman who suffered from a small tumor of the breast which had developed in the course of a few days. After the disappearance of the tumor, nodules the size of beans were found in the skin. From one of these the worm was obtained. Brumpt[2] notes that similar tumors were also found by Deuntzer in two other sick persons after a slight febrile period. In one of these five or seven worms were expelled. He also calls attention to the fact that the parasite has been encountered again in Siam by Kerr (Leiper), by Robert (1922), and in a Chinaman from the Malay States by Samy, and in a Chinaman in a case of "creeping disease" (Y. Ikegami, H. Tamura). Apparently no mention has been made of intestinal invasion with this parasite in man.



No. 396. — Photomicrograph of section of nodule in the stomach of leopard *Felis pardus* containing *Gnathosthoma spinigerum* Owen, illustrating thinning of the epithelium on the right and bulging of the muscular coat on the left. Cross-sections of the parasites in the submucosa are visible in the center of the nodule

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[1] Levinsen: "The Animal Parasites of Man" by Fantham, Stephens, and Theobald (1916), p. 385.

[2] Brumpt: "Précis de Parasitologie" (1927), p. 785.

Lion, Felis leo. The only parasite found in the lion was a species of *Cylicospirura* which was located in the alimentary tract. The adult parasites illustrated in No. 399, Fig. 1, were found in the small intestine, together with the ova, while a few motile embryos were found in the lower part of the small intestine. The adult parasite measured about 2.5 to 3 cm. in length and the ova 40μ in length. Sandground, who has studied and identified this parasite since our return to this country, points out that a most characteristic feature is the nature of the buccal armature. There is a funnel-shaped buccal cavity supported by elbow-joint, chitinous walls. Internally there are six bifid tooth-like structures which take origin near the base of the funnel and project slightly beyond the margin of the mouth cavity. This is illustrated in Figure 2. In Figure 1 may be seen the anterior portion of the female and character of the female genitalia, showing the winding vagina and uterus.

Cylicospirura subaequalis has been described previously by Vevers [1] from the stomach of the tiger. Sandground has pointed out the differences in Vever's description and the specimen he has examined from the present lion (page 480). This parasite also has apparently been found at least in one instance in the leopard, *Felis pardus,* Sierra Leone, according to the label on the tube of material sent Dr. Sandground for comparison through the courtesy of Professor Yorke of the Liverpool School of Tropical Medicine.

The examination of the alimentary tract of the lion at the time of the necropsy did not reveal any visible lesions. From the study of the sections of the intestine of the lion, it would also appear that *Cylicospirura* was not a serious parasite to the animal in question. In the small intestine there is in places slight evidence of a catarrhal exudate on the surface of the mucosa, but there are no ulcers or erosions apparent and no evidences of encysted parasites. There is, however, in certain areas very extensive cellular invasion of the mucous membrane and the eosinophils in sections of the small intestine are enormously increased in number. These changes are not observed in the sections of the large intestine, where the adult parasites were not found. No sections of the parasites or ova, however, were found in the crypts of the mucous membrane or within the villi of the small intestine. Sections of the other organs of the animal are apparently normal.[2]

Neveu-Lemaire [3] in connection with the viruses of the human infections that may occur in the lion mentions only anthrax and rabies each observed in one instance in lions of menageries.

He also refers to the fact that the lion may harbor *Porocephalus armillatus* Stiles, 1893 (= *Armillifer armillatus* Sambon, 1922) in the adult stage, the larval stages of which have been reported in man. The occurrence of *Toxocara mystax* (= *cati*) has also been reported in the intestine of the lion by Zeder.[4] Stiles [5] notes that there have been nine cases of infection with this parasite in man.

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[1] Vevers: Proc. Zoolog. Soc., London (1922), p. 909.

[2] Bequaert has identified ticks collected from the skin of this lion as *Haemaphysalis leachii* (Audouin), see page 810.

[3] Neveu-Lemaire: *Loc. cit.*, p. 252.

[4] Zeder: Yorke and Maplestone, "Nematode Parasites of Vertebrates" (1926), p. 258.

[5] Stiles: Key Catalogue for the Worms Reported for Man, U. S. Hyg. Lab. Bull. No. 142 (1926), p. 156.

Isospora felis Wenyon, 1926, and *Eimeria felina* Nieschulz, 1924, have also been reported in the faeces of lions in menageries in Berlin and Leningrad.[1]

Metcalf [2] in a most interesting article has recently discussed the aid which parasites give in the problems of taxonomy, geographical distribution and paleogeography. Hegner [3] further points out that the protozoan parasites of monkeys and man belong for the most part to the same species or are so similar in their structure, life cycle and host-parasite relations as to be practically indistinguishable. He concludes that if the proposition is valid that close relationships of parasites indicate a common ancestry of their hosts, then the facts available regarding the protozoan parasites of monkeys and man furnish evidence of importance in favor of the hypothesis that monkeys and man are of common descent. Possibly zoologists may find in the occurrence of *Cylicospirura* so far only in the leopard, tiger, and lion a somewhat similiar relationship of common ancestry in these animals.

[1] Rastegaïeff: Bull. Soc. Path. Exot. (1929), XXII, 641.

[2] Metcalf: Smithsonian Misc. Col. (1929), LXXXI, 1.

[3] Hegner: *Loc. cit.*

PART III

MEDICAL AND BIOLOGICAL INVESTIGATIONS

XXVIII

NOTES AND DESCRIPTIONS OF SOME PARASITIC HELMINTHS COLLECTED BY THE EXPEDITION

By J. H. Sandground

The following paper, constituting part of the report on the parasite collection, contains a description of a new species of the trematode genus *Dicrocoelium*, from the liver of a monkey, a new genus of the nematode family Strongylidae, also from a monkey, and a new species of the trichostrongylid genus *Oswaldocruzia* from a lizard. *Nematodirus hopkeni* (Leiper 1907) from the hippopotamus was well represented in this collection, and as a result of the reëxamination of this parasite it is considered necessary to remove it from the genus *Nematodirus* and to create a new genus for its reception.[1]

Other new worms, the descriptions of which are published here for the first time, are: — *Oxyspirura elani* from a kite and a larval spirurid, which we have named *Agamospirura liberiae*, from tumor-like cysts of the intestine of a mongoose. In addition to the above there are included more extensive descriptions of *Anoplocephala gorillae*, the only tapeworm known from the gorilla, and *Cylicospirura subaequalis* from the lion, of which previous descriptions are insufficient or incomplete. Notes and comments made incidental to our identifications of such forms as *Cysticercus pisiformis*, *Streptopharagus pigmentatus*, etc., that may be of taxonomic interest have also been added.

As a matter of record, a list is appended of parasites present in the collection which could be identified generically, and in some instances specifically, with the material available.

An asterisk denotes a new host record of a previously described species of parasite.

TREMATODA

Parasite	*Host*	*Locality*
Fasciola hepatica Linnaeus, 1758	*Bubalus caffer*............	Ituri Forest, Belgian Congo.

CESTODA

Parasite	*Host*	*Locality*
Anoplocephala gorillae Nybelin, 1927......................	*Gorilla beringei*...........	Lake Kivu, Belgian Congo.
Bothridium ovatum Diesing, 1850	*Python* species...........	Ruchuru River, Belgian Congo.

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[1] Descriptions of these parasites have also been published in No. 2783. — Proceedings U. S. National Museum (1929), Vol. 75, Art. 12.

NEMATODA

Murshidia species	*Loxodonta africana*	Semliki Valley, Belgian Congo.
Cobboldina vivipara Leiper, 1911	*Hippopotamus amphibius*	Lake Edward, Belgian Congo.
Setaria labiato-papillosa (Alessandrini, 1838) Railliet and Henry, 1911	*Bubalus caffer*	Ruindi Plains, Belgian Congo.
Setaria poultoni Thwaite, 1928	*Damaliscus corrigum jimela*	Ruindi Plains, Belgian Congo.
Setaria hornbyi Boulenger, 1921	**Cobus defassa*	Ruindi Plains, Belgian Congo.
Cylicospirura subaequalis Molin, 1860	**Felis leo*	Ruchuru Plains.
Ophidascaris filaria (Dujardin, 1845) Baylis, 1921	*Python* species	Ruchuru Plains.
Streptopharagus pigmentatus (Linst., 1897) Railliet and Henry, 1918	**Cercopithecus diana*	Liberia.
Trichuris trichiura (Linnaeus, 1771) Stiles, 1901	**Cercopithecus diana*	Liberia.
Enterobius species	**Cercopithecus diana*	Liberia.
Strongyluris brevicaudata Müller, 1894	*Agama colonorum*	Liberia.
Saurositus agamae Macfie, 1924	*Agama colonorum*	Liberia.

TREMATODA

Family DICROCOELIDAE

The material collected from the liver of a species of *Colobus* monkey shot in the Ituri Forest, south of Lake Albert, Belgian Congo, consisted of some fifteen small trematodes, which had been fixed in Zenker's solution. Of this number only three or four are not contracted and generally distorted to the extent that the structure of the parasites cannot be profitably studied. The measurements given in the following description were taken from the most favorable specimens available mounted in gum damar after staining in carmine.

DICROCOELIUM COLOBUSICOLA, new species

Specific diagnosis. Dicrocoelium: Length 3.6 mm. to 5.2 mm. The greatest width in the largest specimen is 1.9 mm. at a post-equatorial point level with the posterior border of the yolk glands. The body is thin and flat with weakly-developed musculature. The specimen least contracted, and hence chosen to represent the type, is spindle-shaped, the body tapering gradually to a rounded extremity anteriorly. In other specimens the preacetabular region is drawn out into a rather narrow neck. The superficial cuticle is devoid of scales, but the presence of numerous subcuticular cells gives it a granular appearance which to some extent masks the internal structure so that the more delicate details are difficult to determine. Oral sucker circular in outline, from 0.22 mm. to 0.28 mm. in diameter. It is terminal and ventral, with strong muscular rim nearly 90μ wide. The oral aperture is subterminal and semilunar in shape. Muscular pharynx, 0.08 to 0.12 mm. in length, followed by a narrow oesophageal region, about 0.15 mm. long, which bifurcates to form the intestinal caeca. Intestinal caeca simple, thin-walled, and so narrow that in some specimens their presence is determined with difficulty. In other specimens the caeca are about

0.12 mm. wide and run a slightly undulating course posteriorly on either side of the acetabulum to terminate in a small vesicle, just behind the middle of the body. The course of the intestinal caeca is usually entirely external to the vitellarian fields, but in some specimens the crest of the undulations overlie the vitelline glands. The acetabulum is muscular. In diameter it ranges from 0.20 to 0.28 mm., being slightly smaller in size than the oral sucker. The excretory vessel is a simple narrow tube, the lateral horns of which are not visible in mounted specimens. It opens at the posterior extremity of the body into a slight indentation of the contour of the body.

Male genitalia. The testes are situated in the second quarter of the body. In the convenient terminology used by Stiles and Goldberger[1] (1910) to describe the topography of the organs of trematodes, both the zones and fields of the two testes would be said to overlap, and the testes abut on their internal borders. In the type specimen the testes are deeply lobed and the area of the anterior testis is perhaps a little smaller than that of the posterior. In other specimens a lobed condition of the testes is not noted. The vasa efferentia and the vas deferens are presumably too delicate to be observed in toto-mounts, but a well-developed, although small cirrus, which is somewhat coiled, can be seen. The genital atrium, which receives the cirrus, is situated just posterior to the point of bifurcation of the oesophagus.

Female genitalia. The ovary, measuring about 0.22 mm. by 0.28 mm., occupies a position immediately behind the right testis. It is usually ovoid in shape, sometimes almost spherical. A large receptaculum seminis, about 0.13 mm. in diameter, lies posterior to and in the same longitudinal field as the ovary. Neither Mehlis's gland nor Laurer's canal was observed. The coils of the massive uterus are so massed together that the usual ascending and descending branches are not distinguishable. The transverse coils of the uterus occasionally extend almost to the margin of the body. The vitellaria consist of large aggregations of glands connected by rather narrow longitudinal ducts forming a moniliform band, which stretches on each side from a point just posterior to the vesicula seminalis to about the equator of the body. The transverse vitelline ducts were not conspicuous. The eggs in the posterior coils of the uterus are of a golden yellow color, but become darker as they advance toward the metraterm. In this part of the uterine tube, which passes directly under the acetabulum, the eggs measure 44μ to 48.2μ in length by 28.3μ in width; they have a slight shoulder, and are operculated.

Host. *Colobus rufomitratus.*

Location. Liver (bile ducts).

Locality. Ituri Forest, Belgian Congo, May 21, 1927.

Type. Cat. No. 8012, U.S.N.M., Helm. Coll.; Cat. No. 8013, U.S.N.M.

Paratypes. Helm. Coll.

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[1] Stiles, C. W., and Goldberger, J.: A study of the Anatomy of *Watsonius* (*n. g.*) *watsoni* of Man. Hygienic Lab. Washington (1910), Bull. No. 60, pp. 1–264.

Systematic Position

The species described above is a typical member of the genus *Dicrocoelium* Dujardin, 1845, the number of species of which is large. They are distributed in a cosmopolitan manner in reptiles, birds, and mammals, usually occupying the bile and pancreatic ducts. The course that the intestinal caeca pursue, external to the line of vitelline glands is rather unusual, but the present species shares this character, at least, with *D. hospes* Looss,[1] 1907, found in Egyptian cattle, and with *D. macrostomum* Odhner,[2] 1911, of *Numida ptilorhyncha* from the White Nile. The present species resembles *D. macrostomum* to a remarkable extent, the two forms being almost identical with regard to the size and disposition of the organs. The only differences that can be detected from Odhner's description of the species concerns the inconspicuousness or absence of a receptaculum seminis (not mentioned in *D. macrostomum*) and a slightly greater length of the intestinal caeca relative to the total length of the body. The former difference may be apparent rather than real, depending upon the physiological condition of the genitalia at the time of examination, and the latter difference is so small as to be of doubtful significance. It seems, however, rather unlikely that the present material coming from a monkey is identical with the flukes from a bird derived from a totally different locality. For this reason, it is proposed to credit the two points of morphological difference, noted above, with specific value. The name, *D. colobusicola,* is provisionally proposed for the material under consideration, pending the opportunity for making a comparative examination with *D. macrostomum.*

Family TRICHOSTRONGYLIDAE

LEIPERIATUS, new genus

Generic diagnosis. Trichostrongylidae: Dorsal lobe of bursa reduced. Two spicules, with relatively massive proportions, ridged, proximal, and with flexible, filiform terminal appendages.

Type species. Leiperiatus hopkeni (Leiper, 1910), new combination.

LEIPERIATUS HOPKENI (Leiper, 1910), new combination

Synonym. Nematodirus hopkeni Leiper, 1910.

Specific diagnosis. Leiperiatus: In the preserved state the worms are of a greenish-yellow color. The cuticle is finely striated transversely, and there is also a series of a dozen or more longitudinal lines extending the entire length of the body. The cuticle of the head is not inflated. The head is about 24μ wide at the extremity. The mouth cavity is surrounded by four papillae, two subdorsal and two subventral, and a pair of amphids, laterally. The amphids, which are well developed, are considerably larger than the papillae, which are minute and inconspicuous. The buccal cavity is very shallow and into it there projects a very definite, although at times obscured, cuticularized spine, about 6.5μ long, which arises from the floor of the mouth. The oesophagus, of the typical trichostrongyle type, widens only slightly posteriad. It is about one-twelfth of the body length in the male and about one-ninth of the body length in the female. The nerve ring embraces the oesophagus anteriorly in the first quarter (0.28 mm. to 0.32 mm. from its anterior end), and at the same level the excretory tube opens by a fine duct on the ventral surface. Cervical papillae were not observed in the material at hand. They may be present as minute acicular points, which are stated by Leiper to project 0.4 mm. behind the nerve ring.

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[1] Looss, A.: Notizen zur Helminthologie Aegyptiens. VII. Ueber einige neue Trematoden der ägyptischen Fauna. Centralbl. f. Bakteriol., etc. (1907). Orig., Jena, Abt. 1, vol. XLIII (pt. 5), pp. 478–490.

[2] Odhner, T.: Results of the Swedish Zoological Expedition to Egypt and the White Nile, 1901, under the direction of L. A. Jägerskiöld. Upsala. (1911). No. 23*a*. Part 4. Fascioliden. Pp. 1–166.

Male. 12 to 13.4 mm. long with a maximum thickness of 0.23 mm. The bursa consists of two symmetrical lateral lobes united by a small unindented lobe, dorsally. The lateral lobes are figured, seemingly over the entire internal surface, with macular markings arranged to form a delicate mosaic design, and their posterior margins are finely scalloped by the cuticular striae which are quite conspicuous in this region. The small dorsal lobe is supported by a single dorsal ray, of proportionately reduced dimensions, which bifurcates near the middle of the lobe. Each of the bifurcations terminates in two minute digits which are slightly curved and extend to the margin of the lobe. The lateral lobes are supported by six rays of which the latero-ventral and ventro-ventral, as seen in the normal condition of the bursa, appear to be closely approximated, but when the lobes are spread out it is seen that the tips of these rays are well separated. The three lateral rays are parallel; the postero-lateral is the smallest and the medio-lateral the stoutest. The externo-dorsal ray, the basal origin of which could not be definitely determined, is very slender. A pair of exceedingly minute prebursal papillae are also present.

The spicules are equal in size, about 0.31 mm. in length, and brown in color. Each is composed of a proximal and terminal portion. The proximal portion, about 0.18 mm. long and 0.025 mm. broad, is adorned with one or two, somewhat twisted, longitudinal crests or ridges, and appears to be tubular in form. The distal portion is filiform and flexible, often being bent, as Leiper described, in the form of an interrogation mark. The tips of the spicules are not united by a membrane. The genital cone lies ventral and just anterior to the dorsal lobe of the bursa. It is ornamented with tubercle-like papillae, but details of this structure could not be seen in the material available.

Female. 18 to 22 mm. long with a maximum diameter of about 0.30 mm. near the middle. The terminal part of the intestine is narrowed to form the rectum with cuticularized lumen which opens at a point where the body is 0.12 mm. wide, about 0.37 mm. from the posterior extremity. The body narrows gradually to form a conical tail. The vulva is without salient lips and, in a specimen 19.3 mm. long, is situated 4.5 mm. from the posterior extremity. The long uteri open through divergent muscular ovejectors into a short vagina. The eggs are ellipsoidal and have thin shells which measure from 66μ to 73μ long by 40μ wide.

Host. Hippopotamus amphibius.

Location. Stomach.

Locality. Lake Edward, Central Africa, April 17, 1927.

Specimens. Males and females, Cat. No. 8014, U.S.N.M., Helm. Coll.

The above description is based upon material collected and preserved separately from two hippopotamuses. The parasites, of which about twenty worms were collected from each animal, appear to be identical, but the material in one tube only was in reasonably good condition for study; because of the fixation the material from the second animal could not be cleared to show the internal anatomy. The species was first recorded and briefly described by Leiper[1] (1910), who collected it from a hippopotamus shot in the Uganda and named it *Nematodirus hopkeni.* Leiper's description is unfortunately incomplete, and the diagrams accompanying the description are not accurate enough in certain details to be of service for the identification of the parasite. The shape of the spicules, however, is so distinctive that although the range of the present material is slightly larger than shown by Leiper's figures, there can be little, if any, doubt that we are concerned with the same species. Leiper described the bursa of the male as being devoid of a posterior or dorsal lobe and its supporting dorsal ray. This discrepancy from the present description can be accounted for by the fact that this organ, although it must be constantly present, is inconspicuous. It was exposed and visible in only two of the four male specimens examined. In preparing the description presented above, a number of significant points of divergence were found distinguishing the species from the twelve or more species of the genus *Nematodirus,* and calling for a reconsideration of the taxonomic status of the worms. One of the most outstanding differences concerns the spicules, which in their filiform shape and membranous union are a constant feature of all other species of *Nematodirus.* The inclusion of "*N. hopkeni*" in the genus breaks the natural homogeneity of the spicule character and, particularly if other significant morphological differences could be found to support the action, it would be advisable to remove the species *N. hopkeni* from the genus *Nematodirus.* A comparison of "*N. hopkeni*" with other described species of *Nematodirus* provides the following additional points of departure:

	"*N. hopkeni*"	*Other species of Nematodirus*
1. Cuticle of head	Not inflated	Inflated.
2. Position of excretory pore	At level of nerve ring	Opposite extremity of esophagus.
3. Size of eggs	73μ by 40μ	95μ to 230μ by 70μ to 110μ
4. Shape of tail in female	Conoid	Truncated, with terminal spike-like process.
5. Dorsal lobe of bursa	Very reduced. Simple in outline.	Larger with indented margin.

These differences are of greater than specific magnitude and warrant the removal of "*N. hopkeni*" from the genus *Nematodirus.* I propose creating for its reception the new generic name *Leiperiatus* in honor of the original describer of the parasite.

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[1] Leiper, R. T.: The entozoa of the *Hippopotamus.* Proc. Zool. Soc. London (1910), pp. 233–251.

Family TRICHOSTRONGYLIDAE

OSWALDOCRUZIA AGAMAE, new species

Specific diagnosis. Oswaldocruzia.

Male. Length 7.4 mm.; greatest breadth 0.15 mm. near middle of body from which point there is a gradual tapering toward the anterior end, where the body is 0.03 mm. wide. The head is rounded and bears four inconspicuous oral papillae and two amphids. The cephalic cuticle is inflated for a distance of about 35μ. The only occurrence of striae on the cuticle is for a short distance behind the cephalic inflation, the cephalic cuticle itself being as devoid of striae as the remainder of the body. The oesophagus is 0.34 mm. long, claviform, and encircled by the nerve ring, slightly anterior to its middle. A minute cervical papilla is found opposite the nerve ring. The excretory pore is situated just anterior to the base of the oesophagus.

The bursa is slightly longer than broad, and its comparatively narrow supporting rays, as indicated in the accompanying diagram, are according to the plan characteristic of the genus. A small dorsal lobe is easily distinguishable. The dorsal ray bifurcates near its end, and each branch is split into three rather minute digitations. The spicules are of a light yellow color. They measure about 0.175 mm. in length, and at their broadest point, near the anterior end, measure 17μ wide. They are very slightly ridged, not spirally fluted, and their termini are adorned with a few inconspicuous processes. Gubernaculum absent.

Female. Length from 11.5 to 12 mm.; greatest breadth 0.19 mm. The oesophagus is 0.55 mm. long and the cephalic inflation measures about 0.05 mm. in length. The vulva is situated 7 mm. from the anterior end, dividing the body in the ratio of 3:2. The uteri are divergent, and the anterior ovary extends forward almost to the level of the base of the oesophagus where it is reflected backward. The eggs, which become embryonated before oviposition, measure on the average 86μ by 45μ. The body of the female tapers gradually to end in a conoid tail to which a fine acicular process is appended.

Host. Agama colonorum.

Location. Intestine.

Locality. Du River, Liberia.

Type. Male and female, Cat. No. 8015, U.S.N.M., Helm. Coll.

Paratypes. Male and females, Cat. No. 8016, U.S.N.M., Helm. Coll.

The species described above, which appears to be the first member of the genus described from an African reptile, may be differentiated from previously described members of the genus on the basis of (1) its unstriated cephalic cuticular swelling, (2) the narrow and relatively simple spicules, which are also shorter than in other species, and (3) the smaller eggs.

NEMATODA

Family STRONGYLIDAE

COLOBOSTRONGYLUS, new genus

Generic diagnosis. Strongylidae: Comparatively large worms with mouth directed straight forward. Buccal capsule infundibular and with thick walls. An external leaf crown with numerous slender elements and an internal leaf crown of minute elements present. Only the amphids, or so-called lateral papillae, are prominent in the circumoral region. Cervical papillae very minute or absent. Anterior portion of oesophagus bent away from the main axis of the oesophagus; from its dilated funnel-shaped portion, three narrow teeth project into the mouth capsule. Male bursa with lateral lobes and an inconspicuous dorsal lobe. Ray formula as in genus *Oesophagostomum.* Spicules long and narrow, with knobbed proximal ends and without a sheath. Gubernaculum present. Tail of female mucronate. Anus and vulva open close together near tail. Vagina long, opening into two kidney-shaped chambers (*pars ejaculatrix*) which communicate with long ovejectors and parallel uteri.

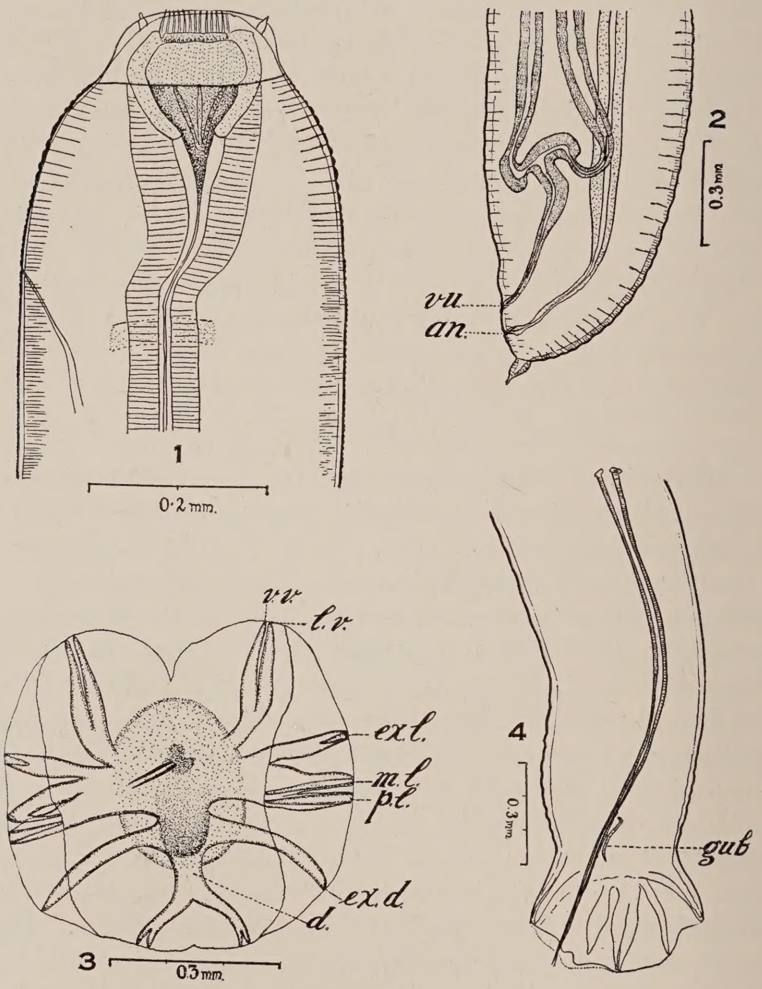
Type species. *Colobostrongylus strongi,* new species.

COLOBOSTRONGYLUS STRONGI, new species

Specific diagnosis. *Colobostrongylus:* In the preserved state the worms are girdled either at their anterior or posterior extremities with a belt of brownish-black material resembling clotted blood. They are yellowish in color and robust in build. Body cylindrical, tapering toward the anterior extremity. The cuticle is finely striated, and, as a marking superimposed on the general striation, the cuticle is coarsely crinkled in the anterior and posterior regions of the body. Head region well defined. There are four circumoral papillae and two amphids, or so-called lateral papillae. The submedian, dorsal, and ventral papillae are flat, and visible only when the head is cut off and viewed on end. The amphids are fairly conspicuous, and with a broad base, provided with a terminal sensory filament. Mouth directed straight forward, with comparatively narrow mouth collar. Diameter of mouth, 0.085 mm. Mouth capsule broader than long, measuring 0.12 mm. by 0.11 mm., and with a thick chitinous wall. The dorsal gutter of the oesophageal gland was not visible, and is probably absent. There are two leaf crowns, the external composed of twenty-four narrow elements, which project for a short distance beyond the mouth aperture, and an internal leaf crown consisting of exceedingly minute peg-like elements, whose number cannot be accurately computed. The oesophagus is clavate, the posterior swollen portion being 230μ wide. Its anterior quarter is bent at an angle from the main axis of the oesophagus, and anteriorly it is widened out to form a funnel from the base of which there projects, halfway into the buccal cavity, a chitinous trident composed of three narrow lancets. In some specimens the trident is rather difficult to see on account of débris obscuring the view. Excretory tubule very narrow, opening at a level with the kink in the oesophagus, 0.31 mm. from the anterior extremity. Cervical papillae were not visible.

EXPLANATION OF ILLUSTRATIONS Nos. 397 and 398

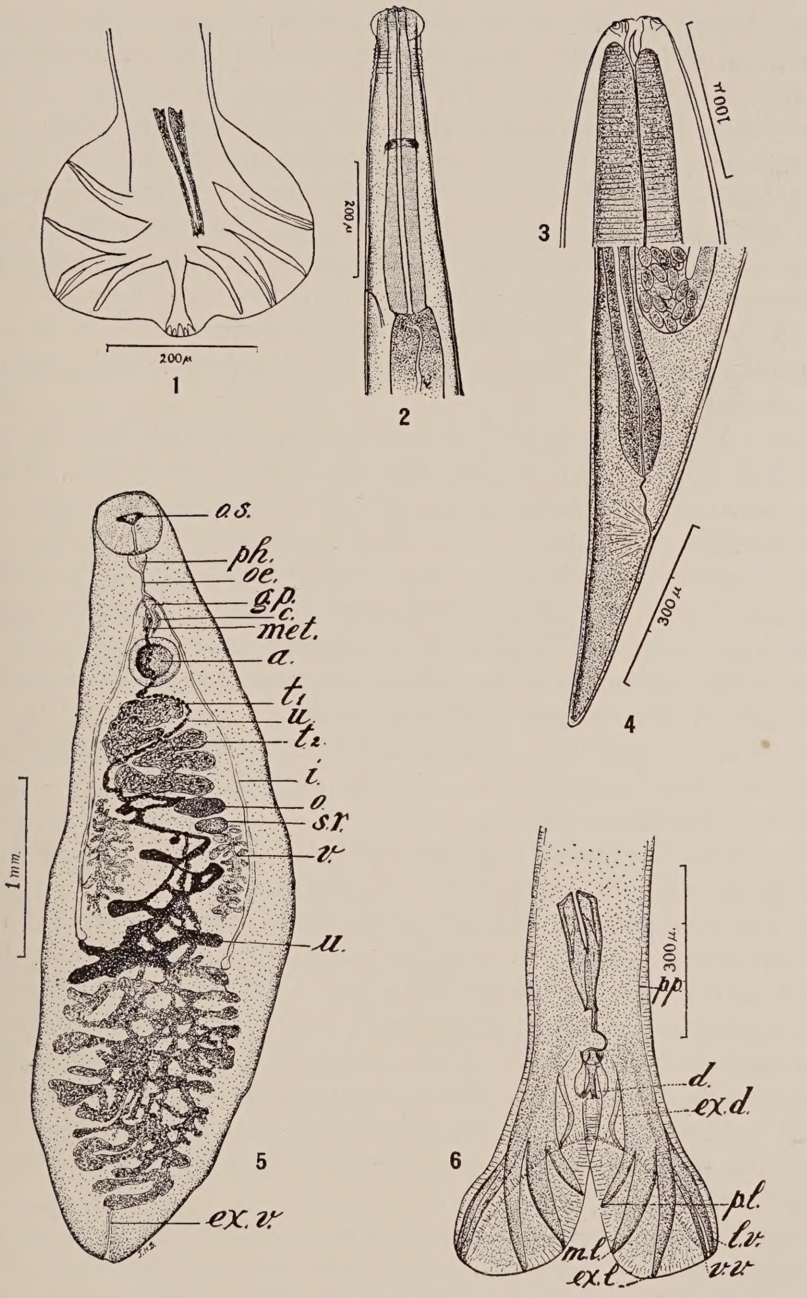
Abbreviations: *a.* acetabulum; *an.* anus; *c.* cirrus organ; *d.* dorsal ray; *exd.* externo-dorsal ray; *exl.* externo-lateral; *exv.* excretory vessels; *g. p.* genital pore; *gub.* gubernaculum; *i.* intestinal caeca; *l. v.* latero-ventral; *met.* metraterm; *m. l.* medio-lateral; *o.* ovary; *oe.* oesophagus; *os.* oral sucker; *ph.* pharynx; *p. l.* postero-lateral; *pp.* prebursal papilla; *s. r.* seminal receptacle; *t1* and *t2* anterior and posterior testes; *u.* uterus; *v.* vitellaria; *vu.* vulva; *v. v.* ventro-ventral.



No. 397

Colobostrongylus strongi

FIG. 1. Anterior extremity showing buccal teeth and kink in oesophagus.
2. Posterior extremity of female showing vulva, vagina, etc.
3. Bursa of male flattened out to show distribution of rays.
4. Posterior extremity of male.



200μ
1
200μ
2
100μ
3
300μ
4
o.s.
ph.
oe.
g.p.
c.
met.
a.
t₁
u.
t₂.
i.
o.
s.r.
v.
u.
ex.v.
1 mm.
5
6
300μ.
pp.
d.
ex.d.
pl.
l.v.
m.l.
ex.l.
v.v.

No. 398

FIG. 1. *Oswaldocruzia agamae,* caudal extremity of male with bursa spread.
2. *Oswaldocruzia agamae,* anterior extremity of female.
3. *Leiperiatus hopkeni,* anterior extremity from the dorsal aspect.
4. *Leiperiatus hopkeni,* caudal extremity of female viewed from the side.
5. *Dicrocoelium colobusicola,* ventral view showing topography of organs.
6. *Leiperiatus hopkeni,* caudal extremity of male with bursa spread.

Male. From 24 mm. to 26 mm. in length with a maximum breadth of 0.47 mm. near the middle. Bursa short, measuring 0.23 mm. long by 0.4 mm. wide. Ray formula similar to that of the genus *Oesophagostomum;* ventral rays cleft near their base and parallel. Externolateral and other lateral rays arise from a common trunk; the former diverges and its tip does not quite reach to the margin of the bursa, while the mediolateral and posterolateral rays are parallel, and extend to the margin of the bursa. The externodorsal rays, which are relatively slender, arise from a common trunk with the dorsal ray. The latter divides near its middle, and each branch bifurcates terminally. Spicules equal in length, filiform and unsheated. They measure 1.23 mm. in length, and their termini are without barbs. A slender, curved gubernaculum, about 0.10 mm. long, is present.

Female. From 30 to 31 mm. in length, with maximum breadth in the posterior half of the body of 0.78 mm. Oesophagus 0.78 mm. long. Measurements of buccal cavity approximate those of the male. The posterior half of the body tapers conically, to terminate in a sharp mucronate tail. Anus opens about 0.15 mm. from tip of the tail, and the vulva, which does not have salient lips, is situated about an equal distance anterior to the anus. Muscular vagina about 0.28 mm. long. It bifurcates into two more or less kidney-shaped chambers, that receive two convergent ovejectors, which are continuous with the parallel uteri. Eggs (in uterus) thin-shelled, measuring, on the average, 80μ by 40μ.

Host. *Colobus polykomos* ("Black and white" Colobus monkey).

Location. Small intestine (?).

Locality. Du River, Liberia.

Type. Male and female, Cat. No. 8017, U.S.N.M., Helm. Coll.

Paratypes. Cat. No. 8018, U.S.N.M., Helm. Coll.

Nine female and seven male specimens of the parasite described above were found free in the lumen of the small intestine of the host, which, at the time of examination, had been dead for several hours. Cysts, the size of a pea, resembling those produced by *Oesophagostomum* were seen by Dr. Max Theiler, a member of the Expedition, on the walls of the caecum, but on dissection of one of these cysts no parasites were found. Because of the generic affinities of the worms, it seems not unlikely that the normal habitat of the parasite is in the large intestine and that, in the present case, postmortem migration had occurred (see also page 420).

The characters described in the diagnosis cannot be reconciled with those of any known genus of the Strongyloidea. On the basis of the shape of the buccal cavity and the associated oral structures, the status of the parasite would seem to fall between the two chief subfamilies, the Strongylinae and the Trichoneminae, but in other characteristics it exhibits affinities with the Oesophagostominae. The shape of the buccal cavity is closer to that of the Strongylinae, but the absence of a dorsal oesophageal gland prolonged as a ridge on the dorsal wall of the buccal capsule is more characteristic of the Trichoneminae. If it were not for the lack of a transverse ventral cervical groove and of any semblance of cephalic inflations, an affinity with the Oesophagostominae would be indicated, especially since the bursal ray formula is practically identical with, and the dental armature of the oesophagus resembles these structures in *Ternidens*, a typical genus of the Oesophagostominae. In view of these considerations, the writer has refrained from indicating the subfamily relation of *Colobostrongylus*. It seems, however, that the Oesophagostominae, as at present defined, constitute an artificial group, necessitating the allocation to other subfamilies of several genera (as *Oesophagostomoides* Schwartz, 1928) [1] whose characteristics show a close affinity with the type genus *Oesophagostomum*.

Anoplocephala gorillae Nybelin, 1927

The worms are of a buff-yellow color. The strobila increases gradually but uniformly in width from the scolex posteriorly, the most anterior segments being 2.32 mm. broad, and the ultimate segments 12 mm. or more broad. The longest strobila of the seven collected measures 46 mm. The posterior extremity terminates in such broad and narrow segments that it seems likely that segments are shed as soon as they become gravid. Consequently, the specimens in our possession are to be regarded only as fragments. Strobilization extends throughout the entire length of the organism; the largest of our specimens is constituted by more than a hundred segments. The scolex is large, 2.3 mm. wide by 1.29 mm. in length, and is set off from the rest of the strobila by a deep groove fringed at its margins. The suckers are arranged in two pairs, on the dorsal and ventral surfaces respectively. They are directed anteriorly and are covered superficially by a thin, annulated sheet of cuticle forming a sort of hood that covers the suckers (Text Fig. 1). The suckers are 1.19 mm. in diameter, the muscular rims being 184μ broad. They have no appendages.

Segmentation commences immediately behind the neck. The earliest segments are very narrow (about 0.090 mm.) and the rudiments of the developing genital system are visible in the fourth segment. The segments in which the male genitalia are fully developed measure 0.54 mm. in width. The posterior margins of the segments are fimbriated and overlie the anterior portion of succeeding segments to the extent of nearly half the width of the segment.

The muscular system is very strongly developed. Numerous fibers arising from the subcuticular nucleated zones traverse the entire thickness of the segment. Bundles, to the number of more than a hundred, of coarse, longitudinal fibers are somewhat irregularly arranged in the medullary parenchyma, but, in the main, the bundles are disposed in two layers. The sheet of transverse muscle fibers separating the medullary and cortical zones of parenchymatous tissue is also strongly developed. Imbedded in the superficial strata of the cortical parenchyma are exceedingly large numbers of calcareous granules. In the material at hand, the excretory system cannot be followed accurately. In the anterior region of the strobila, longitudinal sections reveal two pairs of longitudinal thin-walled tubes lying side by side in the same plane but running very sinuous courses. In toto-mounts of specimens only a single pair of tubes

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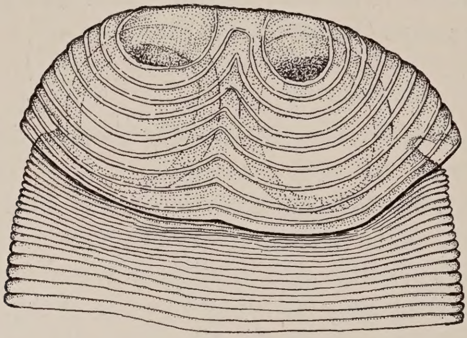
[1] Schwartz, B.: Two new Nematodes of the Family Strongylidae, parasitic in the intestine of Mammals. Proc. U. S. Nat. Mus., Washington (1928), vol. LXXIII, art. 2, pp. 1–5.

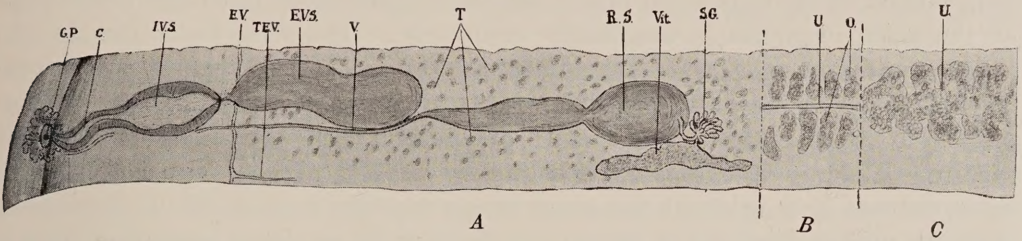
is seen. With the development of the segments one of these ducts (corresponding to the dorsal vessel) loses its identity as a consequence of the development of numerous secondary tubules. On the dextral side this tube, which is about 54μ wide, runs across the cirrus organ in the anterior segments, but as it proceeds its position is shifted inwards so as to run at the side of the nerve cord internal to the cirrus pouch. The fact that transverse excretory vessels running along the posterior edge of the segment unite with the main longitudinal tube indicates that the latter represents the ventral vessel, but in sections it is found to occupy a position, not ventral, but almost exactly in the middle of the segment. Cross-section of the segment reveals in addition to the ventral vessel and its transverse commissures, a series of thin-walled secondary vessels running longitudinally in the dorsal and ventral fields of the medullary parenchyma. The excretory system in this worm is undoubtedly complicated and may take the form of a complex network of vessels.



Text Figure 1. — *Anoplocephala gorillae* Nybelin, 1927; scolex

Reproductive Organs. The strobila is nearly 2 mm. thick, so that only the grosser structures of the reproductive system can be distinguished in the cleared toto-mounts; for the finer details, a study of thick sections, both longitudinal and transverse, is necessary. Even with this procedure, difficulties are encountered in establishing the complete relationship of the female organs. The longest specimen in the collection shows a high degree of arrested development of the reproductive organs. In a few segments near the center of the chain in this specimen, the incipient development of an ovary can be seen, but no signs of male or accessory male organs are to be found; segments more posterior to these do not display any evidence of gonad development. The remaining smaller specimens, however, show a more regular development of the reproductive organs and it is on these specimens that the study has been carried out.

As the following account of the reproductive system will show, the worms have either failed to develop to a fruitful maturity, or the specimens with which we are dealing represent immature fragments of worms which have already shed their gravid segments. For an interesting account of anomalies in the development of the reproductive organs sometimes exhibited by cestodes closely related to the parasite under discussion, and for an interesting explanation that has been suggested for this physiological condition, the reader is referred to the paper of Stunkard[1] (1926), pages 2–3.



Text Figure 2. — *Anoplocephala gorillae* Nybelin, 1927; semi-diagrammatic composite figure

Male Organs. The testes attain their functional condition very early in the development of the strobila. They are first seen in section in the very narrow segments — about the fourteenth segment from the scolex. The mature sperm are rapidly passed into the vas deferens where they accumulate in two or more local dilations of the tube. Such dilations, representing vesiculae seminalis crowded with sperm, are first found in the sixteenth segment. They persist throughout the remainder of the strobila, frequently becoming fused to form a single massive vesical nearly 0.65 mm. in length, and filling the segment to the extent of more than half its width. The testicular follicles are about 40μ in diameter and are too numerous (probably more than one hundred fifty) to be counted accurately. They show a tendency to coalesce into larger secondary agglomerations as the segments grow older and the male glands pass beyond their functional stage. The testes are distributed in a practically uninterrupted field between the lateral excretory vessels, and, as transverse sections show, they occur in sheets two or three deep in the dorsal medullary parenchyma. The sperm pass from the dilated vas deferens, or external vesicula seminalis, into an internal vesicula seminalis which occupies the mesial portion of the spacious piriform cirrus pouch and which may undergo a certain amount of tortion. The walls of the cirrus pouch are thick and muscular, and powerful retractor muscle fibers are attached to it from the transverse muscle sheets of the body. In sections, a few unicellular glands are seen surrounding the entrance of the vas deferens into the cirrus. These cells probably represent a weakly-developed prostate gland. The cirrus organ is a very muscular tube with a narrow lumen lined with a thick cuticula. It opens on the dorsal edge of the segment near its center into a slight bursa, which, at its external openings, is surrounded by puckerings of the cuticle arranged in rosette fashion. The genital orifice of each segment is regularly unilateral throughout the length of the strobila. The cirrus organ was not seen protruded in any segment, and, so far as I have been able to determine from a close scrutiny of the organ in suitable toto-mounts as well as in numerous sections, it is not furnished with a spinous external covering. It may be, however, that the finely-patterned markings seen on the terminal portions of the cirrus pouch could be interpreted as hair-like spines.

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[1] Stunkard H. W.: The tapeworms of the Rhinoceroses, a study based on material from the Belgian Congo. Amer. Mus. Novitates No. 210 (March 10, 1926), pp. 1–17.

Female System. Protandry is a marked feature of the reproductive system. The female organs do not make their appearance until the production of the male elements is practically completed. The first structures in the female system to make their appearance are the accessory female organs (vitellarium, "shell" gland, etc.) which are seen to arise as aggregations of chromophilic cells at a point about one-third of the breadth of the segment from the poral margin. The receptaculum seminis already packed with sperm, then springs into existence and at about the same time a straight narrow tubule lined with elongate cells is observed in the central field of the segment extending from a point near the vitellarium to the neighborhood of the aporal excretory vessel. Very soon thereafter follicles consisting of more or less separate spherical cells with deeply-staining inclusions are found on either side (*i. e.*, both anterior and posterior) of the aforementioned tubule. These follicles represent the ovary and the ova seem to descend directly and apparently at several places into the median tube which becomes dilated and functions as the uterus. The uterus has very thin walls and develops shallow outgrowths. This organ, in our material, contains very immature but apparently fertilized ova. The ova in all my specimens are in this immature condition, and consequently it is not possible to present a description of the mature egg and its enveloping membranes. A careful and extensive study has failed to reveal a well-defined oviduct. In no segment was the vagina seen as an intact tube, but in some sections the poral end of the receptaculum seminis is found drawn out into a wide tube extending laterally as far as the cirrus sac where its lumen becomes occluded. In a few very young segments two parallel lines of cells are found immediately posterior and somewhat ventral to the cirrus organ at the point of its entrance into the genital cloaca. These cells I interpret as destined to form the walls of the vagina, an organ which undoubtedly functions for a very brief period and atrophies soon after receiving sperm sufficient to fill the receptaculum seminis. The "shell" gland and the vitellarium are contiguous with the receptaculum seminis, as shown in the diagram. The paucity of material and the transient nature of the female organs has not made it possible to determine the relationship between these structures so as to establish the mode of fertilization and construction of the egg.

Host. *Gorilla beringei.*

Location. Intestine.

Locality. West of Lake Kivu, Belgian Congo.

The study of this worm was instituted soon after the material was placed in my hands in October, 1927, but a decision as to the systematic disposition of the parasite was not arrived at until a short time before a reprint of a paper by Nybelin[1] (1927) was seen in April, 1928. Nybelin's paper consists of a short general account of a cestode, from *Gorilla beringei* Matschie, collected in the Kivu volcano region by the Swedish Central Africa Expedition of 1921.

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[1] Nybelin, O. 1927. Anoplocephala gorillae. Arkiv för Zoologi. XIX B, No. 4, 3 pp.

It was published as a preliminary report pending the arrival of an opportunity for a more detailed study of the parasite by the author. Nybelin places the material which comes from the same species of gorilla, and is probably identical with our own, in the genus *Anoplocephala* s. str., giving it the name *A. gorillae.* It is evident from his description that the material on which his study was made possessed segments which had reached the stage of maturity in which fully-developed eggs were present. The study of our material has not brought out any considerable deviation from Nybelin's description, but there are two points of major interest on which I am unable to confirm Nybelin's observation. Nybelin describes the ovary as consisting of a ventral stem, transversely directed, from which there arise individual groups of follicles. These follicles are figured lying ventral to and unconnected with the uterine stem. This condition, as indicated in the account above, was not observed in our material in which isolated ovarian follicles are found around the primitive uterine tube, occupying almost the entire thickness of the medullary parenchyma. As far as our studies can show, they are unattached to any stem that functions as an oviduct. The ovary is a massive structure, more comparable in size to the ovary of *Paranoplocephala* (=*Anoplocephala*) *infrequens* (Douthitt, 1915) Baer, 1927, than it is to the rather scanty although extensive series of small follicles as described by Nybelin in whose material the ovary would seem to be in a condition resembling that found by Southwell (1920) in *Anoplocephala gigantea* (Peters, 1856) (=*A. vulgaris* Stunkard, 1926). It is possible, however, that the difference in the structure of the ovary in Nybelin's material and in my own is to be charged either to the mode of fixation of the material or to the stage of development of the organ rather than to any specific differences.

The second point of difference to be noted concerns the absence in our material of a spinous condition of the cirrus organ. These two points of difference would seem to be of minor significance and may perhaps vanish when Nybelin publishes a more comprehensive account of his material.

Cysticercus pisiformis (Bloch, 1780) Gmelin, 1790

In two of four specimens of the "topi" (*Damaliscus corrigum jimela*) several cysticerci or larval tapeworms were found. The parasite occurred both on the surface of the liver and in adventitious cysts on the mesentery. Dissection of the cysts which were somewhat calcified disclosed a single scolex in each. These after prolonged clearing in lactophenol were rendered very suitable for study. The scolex (which measured about 1.5 mm. in diameter) is provided with four muscular suckers, 250μ in diameter. A rostellum is present on which forty-four hooks are mounted in two alternating rows. The larger hooks (270μ to 300μ in length) consist of a well-curved blade, a rather straight handle half as long again as the blade, and a guard or lateral prong which terminates in a bluntly-rounded cone. The smaller hooks measure from 150 to 156μ in length. The blade is even more strongly curved than in the larger hooks; the handle which, seen from the lateral aspect, terminates in a slightly swollen rounded knob, is about half the size of the blade; the guard tapers toward its extremity and is probably bifid, although this point could not be determined definitely in our specimens.

Host. *Damaliscus corrigum jimela* ("topi").

Locality. Near Lake Edward, Congo.

Location. On liver and mesentery.

After comparing our specimens with a scolex of *Taenia pisiformis* from the dog, it is our opinion that the cysticercus encountered in topi conforms well enough with this species to be tentatively taken as its larval form. *Taenia pisiformis* is recorded from both the lion and leopard, both of which abound and doubtlessly prey upon the topi in the locality from which our material was secured.

Trichuris trichiura (Linn., 1771) Stiles, 1901

From the caecum of a red *Colobus* shot in Ituri Forest, Belgian Congo, three adult females of a species of *Trichuris* were obtained. The specific distinctions of members of the genus is made on the basis of length of the spicules and the spinose character of its sheath. According to the recent study of Schwartz[1] (1926) no constant differences in the above-mentioned characters are to be observed in material derived from man, the chimpanzee, species of *Cercopithecus* and swine, although definite variations may be displayed in individual worms. Schwartz concludes that until biological differences in their infectivity are established by cross-infection experiments, the identity of worms from these different hosts must be recognized. It is consequently very probable that the parasite collected from the monkey in this instance is *Trichuris trichiura* (Linn., 1771, Stiles, 1901) the type host of which is man.

Enterobius sp.

A probable member of the genus *Enterobius* is represented in the form of eight darkly colored female worms collected from the same host and in the same location as the *Trichuris* just mentioned. The females are smaller (3.6 mm.) than those of *Enterobius bipapillatus* as described by Gedoelst[2] (1916) from the intestine of a monkey (sp. non det.) of the Congo, and the eggs averaging 56μ by 26μ are also under the dimensions given for *E. bipapillatus*, but otherwise the structure of the female appears to coincide very well with this species. However, in the absence of males from our material, a specific determination is not possible. The fact that the genus *Enterobius*, of which thus far there are at least four species reported, is represented solely from primates, does not afford any further clue to the species involved in the *Colobus* monkey.

Streptopharagus pigmentatus v. Linstow

The material consists of two tubes, one containing seven adults, 6 ♀ and 1 ♂, and the other 29 ♀ and 6 ♂, from the small intestine of two specimens of *Cercopithecus diana diana* shot on the Du River, Liberia.

The genus *Streptopharagus* Blanc, 1912, to which the parasites belong was made the subject of a critical review by Ortlepp (1925). Thus far four species with a possible fifth (*S. intermedius* Ortlepp) [1] have been differentiated. Of these only one species, *S. numidicus* Seurat, 1917, from the Fennec Fox *Vulpus cerdo,* and possibly from the Gerbil also, is not a parasite of Primates.

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[1] Schwartz, B.: Specific identity of whipworms from swine. Washington (1926), Jour. Agric. Research, XXXIII, 311–316.

[2] Gedoelst, L.: Notes sur la faune parasitaire du Congo belge. Rev. Zool. Africaine (Bruxelles.) (1916), V, fasc. 1, 1–90.

The type species *S. armatus* Blanc, 1912, from *Macacus cynomolgus* is recorded by Vevers also from *M. nemestrinus.* A second species, *S. pigmentatus* v. Linstow, is distinguishable, according to Ortlepp, from the type species on the basis of a pronounced inflation of the cuticle in the head region, the larger size of spicules and gubernaculum, and a very slight difference in the size of the eggs. This species originally described from *Cercopithecus albigularis,* is also said to occur in the following African primates: *Cercopithecus pygerythrus, Macacus* sp. *Papio porcarius* and *P. hamadryas.*

A third species, *S. intermedius* from *Cercopithecus patas,* which Ortlepp has tentatively proposed, occupies an intermediate position in so far as the lengths of the spicules go, but does not appear to exhibit any other morphological differences of importance.

The fourth species from Primates, *S. baylisi* Ortlepp, 1925, has been collected from *Papio langheldi* and *P. hamadryas;* its distinction from the other species mentioned on the basis of a series of claw-like structures in front of the cloacal region in the male seems to be well-founded.

The correct disposition of our material from Liberia offers considerable difficulty. The size of the male worms (22 mm. to 24 mm.) and of the female worms (from 32 mm. to 70 mm.) gives no clue to the specific identification, the male worms actually being smaller than the recorded measurements of either *S. armatus* or *S. pigmentatus.* So far as the arrangement of the papillae on the caudal alae goes, it cannot be distingushed from *S. pigmentatus* (synonymous, according to Ortlepp's view, in this case with *S. armatus*) as delineated by Mönnig,[2] 1924. Postanal sessile papillae as described by Ortlepp for *S. armatus* are wanting. The cuticle is slightly dilated in the neck region, but this character together with the deep annulations of the cuticle in the present material may, it seems to me, be a result of the method of fixation. The relation of the lips and of the teeth surrounding the oval aperture is as described by Mönnig (1924) except that the writer was unable to observe three papillae on each of the lips even in a head-on view.

In a female 32 mm. in length the vulva is situated 7.4 mm. from the anterior extremity, consequently dividing the body in the ratio of 1:4.3 but the difference in the relative position of the vulva in *S. armatus* and *S. pigmentatus* (1:4 and 1:3.5) does not appear great enough to make it an important point in the specific diagnosis.

The size of the eggs in our material, 35μ to 38μ by 17.3μ does not fall far from the average egg size in either of the above-mentioned species and might be attributed to either species.

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[1] Ortlepp, R. J.: "A Review of the Members of the Genus Streptopharagus Blanc, 1912," Jour. Helminthology (1925), III, 209–216.

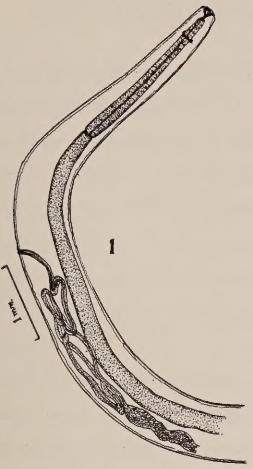
[2] Mönnig, H. O.: "South African Parasitic Nematodes" 9th and 10th Reports of the Director of Veterinary Education and Research (1924), pp. 446–448, figs. 20–22.

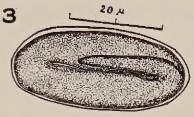
The critical point that remains upon which the specific diagnosis of our specimens must be made rests in the size of the spicules. In *S. armatus* the left spicule length is given as from 4 mm. to 4.25 mm.; in *S. pigmentatus* the length of this spicule is stated as 6.5 mm. to 6.7 mm.

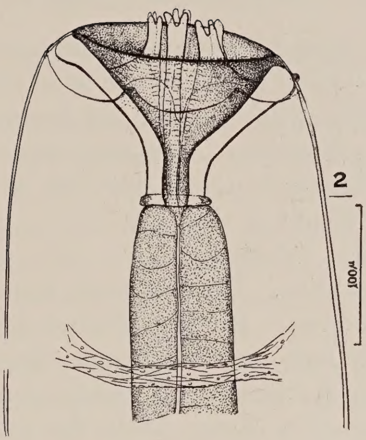
In our material cleared both in glycerine and in lactophenol, the caudal extremities of the specimens are rendered very transparent making details of the caudal papillae, etc., readily visible, but, because of the longitudinal markings of the cuticle and the thickness of the body wall, the fine spicules (10μ wide) and gubernaculum are either entirely obscured or, if visible, are so disposed that accurate measurements, such as are essential if they are to be used as a basis for species differentiation, cannot be secured. In two of the more favorable specimens in which both ends of the left spicule were clearly visible, measurements made as carefully as possible gave lengths of 4.2 and 5.0 mm. This would tend to throw the identification of the parasites into Ortlepp's species *S. intermedius*, but for the reasons given above it does not seem satisfactory to me to make the size of the spicules the sole basis for species differentiation. From general considerations of the specific points discussed above, I believe that the worm from *Cercopithecus diana diana* coincides more closely with the description of *Streptopharagus pigmentatus* than it does with *S. armatus*, and I would therefore assign the material under this name.

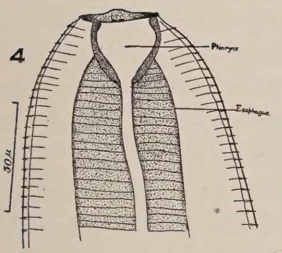
Cylicospirura subaequalis (Molin, 1860) Vevers, 1922

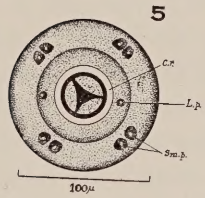
Four specimens, all mature females, killed in formalin, were available for study. Three of these specimens were more or less unbroken; the fourth was cut off in the caudal region of the body. The body is strongly coiled posteriorly. The only specimen that could be satisfactorily straightened measured about 24 mm. in total length. The maximum breadth is 0.56 mm. The cuticle is finely striated. The anterior extremity tapers to a truncated extremity (No. 399, Fig. 1). The oral aperture is hexagonal in shape. The buccal cavity (No. 399, Fig. 2), lined by a thick wall of chitin, is funnel-shaped, with an anterior conical portion, 160μ wide at the rim, and a stem-like posterior portion, or pharynx, which opens into the oesophagus. The depth of the buccal cavity is about 145μ. There are six cuticularized plates more or less triangular in shape, disposed radially in the buccal cavity. The apices of these plates or "teeth" are bifid, and, in some specimens, project slightly beyond the rim of the oral aperture. There are three pairs of cephalic papillae: — a lateral pair (amphids) and two pairs submedian in position. The oesophagus, from 2.4 mm. to 2.96 mm. in total length, consists of the usual, short, glandular part surrounded by a nerve ring 0.35 mm. from the anterior extremity of the body and a longer muscular portion. Neither cervical papillae nor the position of the excretory pore was visible. The tail of the female is bluntly rounded and short, the anus being from 170μ to 250μ from the posterior extremity. The vulva varies in position. In the specimen with the shortest oesophagus (2.4 mm.) it is situated behind the end of the oesophagus, 4.16 mm. from the oral extremity of the body. In the remaining three specimens the vulva lies anterior to the end of the oesophagus, and is not

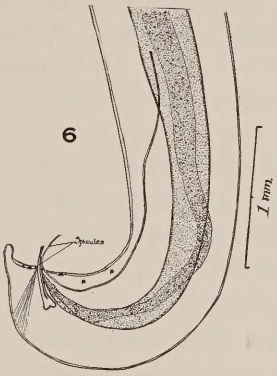


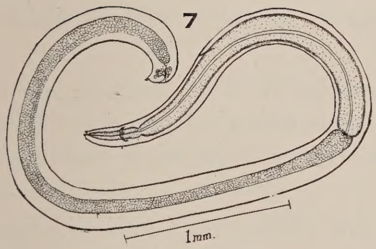


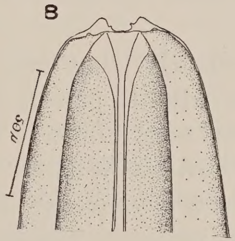


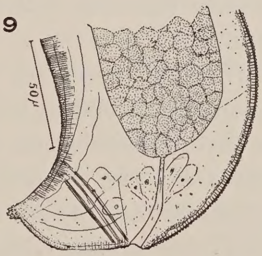

4
Pharynx
Esophagus
30 μ


5
C.p.
L.p.
Sm.p.
100μ


6
Spicules
1 mm.







No. 399. — Fig. 1. *Cylicospirura subaequalis*, anterior portion of female showing position of the vulva posterior to the extremity of the oesophagus.

Fig. 2. *Cylicospirura subaequalis*, optical section of the head showing buccal armature.

Fig. 3. *Cylicospirura subaequalis*, embryonated egg from uterus.

Fig. 4. *Oxyspirura elani*, lateral view of head.

Fig. 5. *Oxyspirura elani*, frontal view of the head.

Fig. 6. *Oxyspirura elani*, posterior extremity of male.

Fig. 7. *Agamospirura liberiae*, larva removed from cyst.

Fig. 8. *Agamospirura liberiae*, lateral view of anterior extremity.

Fig. 9. *Agamospirura liberiae*, lateral view of posterior extremity.

more than 2.2 mm. from the extremity. The ovejector is fairly long. It opens into a blind muscular sac which receives the vagina. The eggs, 43μ long by 18μ broad, are thin-shelled and become embryonated before being expelled into the host's intestine. An examination made by Dr. Strong at the time of autopsy of the chyme from the intestine showed numerous larvae which had apparently hatched out of the eggs.

Host. *Felis leo.*

Location. Free, in small intestine.

Locality. Ruchuru Plains, Congo.

Owing to the unfortunate fact that there is almost a complete lack of measurements accompanying descriptions of *Cylicospirura subaequalis* (= *Spiroptera subaequalis*) Molin, 1860, the type species of the genus in which our material must be accommodated, a specific determination is fraught with uncertainty. It is only because Vevers [1] (1922) had access to some unpublished drawings made by Professor Leiper of Molin's type material of *Spirocerca subaequalis* that we can accept Vevers' statement that *Spiroptera subaequalis* is not congeneric with *S. sanguinolenta* as Seurat [2] (1913) thought it to be, since it is difficult to know how von Drasche (1883),[3] who redescribed and pictured Molin's type material, could have overlooked the prominent bicusped termination of the buccal "teeth." Vevers considers that his material from *Felis tigris,* for which he rightly created the new genus *Cylicospirura,* was identical with *S. subaequalis* Molin. The only difference that he noted between this material and that described by Seurat as *S. subaequalis* from *Felis ocreata* was in the matter of the latter possessing tricuspid teeth whereas the teeth in his material were bicuspid. Chandler [4] (1925) described under the new specific name *Spirocerca felineus* from *Felis domestica* (India) a form undoubtedly belonging to the genus *Cylicospirura* which like Seurat's "*S. subaequalis*" possessed six trifid buccal "teeth." This point of resemblance and the absence of any noteworthy differences in the descriptions indicate that the worms described by Seurat may be identical with *S. felineus* Chandler.

We may consider, consequently, that two species of *Cylicospirura* are at present described in sufficient detail to permit of their being recognized. These are distinguishable on the basis of the bifid or trifid terminations of the buccal teeth and have the following host distribution:

C. SUBAEQUALIS (Syn. *Spiroptera subaequalis* Molin, 1860) from *Felis concolor,* and *F. yaguarondi* (Brazil); *F. mellivora* (Caraca); *F. tigris* (Malaya).[5]

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[1] Vevers, G. M.: (1922). Parasitic Nematoda collected from Mammalian hosts, etc. Proc. Zool. Soc. London (Dec. 1922), p. 909.

[2] Seurat, L. G.: Sur deux Spiroptères du Chat ganté (Felis ocreata). C. R. Soc. Biol. (1913), LXXIV, 676.

[3] von Drasche, R.: Revision der in der Nematoden = Sammlung des K. K. Zool. Hofcabinetes befindlichen Original Exemplare Diesing's und Molin's. Verhandl. der K. K. Zool.-Bot. Gesellsch. Wien (1883), XXXIII, 194.

[4] Chandler, A. C.: The helminthic parasites of Cats in Calcutta. Ind. Jour. Med. Res. (1925), XIII, No. 2, pp. 213–228.

[5] The leopard, *Felis pardus* (Sierra Leone) may be added as a further host of *Cylicospirura subaequalis,* according to the label on a tube of material loaned for the purpose of comparison through the courtesy of Prof. Warrington Yorke of the School of Tropical Medicine, Liverpool.

C. FELINEUS (Syn. *S. subaequalis* of Seurat, 1913) from *Felis ocreata* (Algeria) and *Felis domestica* (India).

The material from the lion described above resembles *C. subaequalis* as described by Vevers in possessing teeth with bifid terminations. The oesophagus measures only about one-tenth the total body length, whereas, if Vevers was right in stating that the measurements of his material from the tiger corresponded in every way, with the exception of the measurements of the buccal capsule, to those of the worm described by Seurat, we must assume that the oesophagus in *C. subaequalis* is not less than one-fourth the total body length. Attention has been called to the rather unusual variation in the position of the vulva with reference to the end of the oesophagus and so this feature cannot be regarded as having differential specific value. The location of the parasite of the lion, free in the intestine and not encysted in the walls of the oesophagus or stomach, as noted in other species, may or may not be of specific significance in this instance. Further than to note these differential points the parasite from the lion cannot be distinguished from *Cylicospirura subaequalis.*

OXYSPIRURA ELANI n. sp.

The material upon which the description is based consists of five male worms fixed in formalin. In the preserved state the worms are collapsed to a flat condition, and consequently the measurements of the width of the body are more than normal. The length is from 10.3 mm. to 11.5 mm.; greatest breadth, 0.93 mm. The body is robust and covered by a transparent, coarsely striated cuticulum. It tapers to an almost acute anterior extremity. Posteriorly the body is curved like an awl to end in an obtusely rounded tail. There are no cephalic cuticular alae, and membranous expansions of the cuticulum are absent in the caudal region. Cervical papillae are easily discernible in one specimen where they are placed asymmetrically 640μ and 750μ from the cephalic extremity on the right and left sides respectively. The mouth (No. 399, Fig. 5), circular in outline, is surrounded by a narrow cuticularized ring, the margins of which do not show indentations or clefts such as described by Ransom (1904)[1] for *O. mansoni.* Two small, lateral papillae, the so-called amphids, are visible and, in addition, when the head is viewed *en face,* four pairs of closely approximated papillae are to be seen in submedian positions. The mouth opens into a more or less hemispherical buccal capsule or pharynx, 45μ in width and about 27μ deep. The cylindrical oesophagus, which does not appear to be divisible into component glandular and muscular portions, is about 0.85 mm. in length. Its lumen, in the anterior region, is found to be triradiate in cross-section. The nerve commissure surrounds the oesophagus 0.32 mm. from the anterior extremity. The position of the excretory pore could not be determined.

The reproductive organs consist of a testis which extends from a point 1.5 mm. behind the oesophagus, and posteriorly is continuous with a thick-walled ejaculatory duct. The cloaca is situated 0.25 mm. from the caudal extremity.

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[1] Ransom, B. H.: Manson's eye-worm of chickens (*Oxyspirura mansoni*) with a general review of nematodes parasitic in the eyes of birds. Bull. 60. Bur. Anim. Ind. U. S. Dept. Agric., Washington (1924), pp. 1–54.

The spicules are very dissimilar. The left spicule, measuring 2.51 mm. in length, is filiform and about 8μ wide. Its proximal end is slightly swollen to form a knobbed head; distally it tapers through a distance of 20μ to terminate in an acute filamentous point. The right spicule is a massive strongly cuticularized structure, measuring 0.47 mm. in length by 43μ in width near its middle. It is arcuate in shape, and on its concave surface is provided with a groove in which the left spicule glides. The proximal part of the spicule is swollen into a double knobbed head, 57μ wide, resembling in shape the head of the human humerus. The sheath of the large spicule is so dense in the specimens available that it simulates a gubernaculum in appearance. Such a structure is, however, absent. The spicules were partially protruded in the five males. An interesting peculiarity of the left spicule is its brittleness; when protruded from the body, manipulation of the specimen may result in this spicule being broken. Such an occurrence may occasion inaccurate descriptions and measurements of spicules with consequent confusion on this point. Three pairs of preanal caudal papillae are fairly easily seen but in some specimens the presence of an additional pair is indicated but cannot be resolved with certainty. A small adanal papilla (? paired) is visible, and two pairs of larger postanal papillae are present. (No. 399, Fig. 6).

Host. *Elanus caeruleus.*

Location. Orbital cavity (? behind nictitating membrane).

Locality. Gbanga, Liberia.

Despite the absence of females from the collection, it is possible to identify the material described above. Reference to the analytical key to the species of the genus given by Cram (1927) [1] and to the description of the species reported as distinct, shows that it is new. The name *Oxyspirura elani* is proposed for its reception. Apparently the only species of *Oxyspirura* previously recorded from Africa (Congo) was *O. mansoni* (fide Cram). The present species, although resembling *O. mansoni* in many respects, differs from it in having a coarsely striated cuticle, a different arrangement of the cephalic papillae, and in the relative sizes of its two spicules. A character that appears to be especially distinctive of *O. elani* is its obtusely-knobbed caudal extremity, which is a feature of all five specimens examined. Additional differences which distinguish *O. elani* from the various other species described may be observed in the size of such structures as the buccal capsule, oesophagus, and spicules. The formula of the caudal papillae, although probably not specifically characteristic, is also found to serve as a basis for differentiating *O. elani* from several of its congeners.

AGAMOSPIRURA LIBERIAE n. sp.

Host. *Crossarchus obscurus* (Mongoose).

Location. Intestine.

Locality. Du River, Liberia.

The material consisted of three tumor-like cysts, 3 mm. to 5 mm. in diameter, which had been excised from the intestine. On dissection, a single nematode larva, coiled in the form of a figure 8, was found in each cyst. The larvae measure 5.7 mm. in length and the greatest breadth is 0.22 mm. The body, which is finely striated, tapers toward each extremity. The anterior extremity is obtuse and bears two lateral cuticular elevations or prominences, 7μ high, each with a minute denticle-like serration on its internal, or oral aspect (No. 399, Fig. 8). The posterior extremity, which is slightly incurved, bears a hemispherical knob ornamented with two to three rows of blunt spines (No. 399, Fig. 9). There appear to be four submedian cephalic papillae. The funnel-shaped buccal capsule, 34μ long and 9μ at its widest point, has thick cuticular walls. The oesophagus, typically spiruroid in character, is divided by a well-marked constriction into a glandular anterior part, 0.28 mm. long, and a muscular posterior portion 1.7 mm. long. The nerve ring encircles the glandular part of the oesophagus 0.2 mm. from the head extremity, and the excretory duct opens ventrally 0.84 mm. from the anterior extremity. The intestine discharges by a short narrow rectum at the anus, about 60μ from the caudal extremity. Several unicellular, gland-like structures are found in the caudal region. No rudiments of developing gonads were observed.

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[1] Cram, E.: Bird Parasites of the Nematode suborders Strongylata, Ascaridata, and Spirurata. Bull. 140. U. S. Nat. Mus., Washington (1927), pp. 1–465.

The specific identity of the parasite described above cannot be determined because of its larval condition, but it evidently belongs to the Spiruroidea. The life-cycle of the few spiruroid nematodes that have been worked out, have all involved an "intermediate" insect host, which, having ingested the embryonated eggs of the parasite, are found to harbor second stage larvae encysted in their muscles or viscera. When the insect host is eaten by the proper vertebrate host, the encysted larvae are liberated by the digestive juices of the stomach or intestine, and proceed to develop to maturity in various locations. However, should the larva become liberated in an unfavorable or foreign host, reencystment, usually in the walls of the alimentary tract, often takes place without any further development. Such a state of affairs was noted by Cram (1924) [1] who, on feeding encysted larvae of a form resembling *Physocephalus sexalatus*, occurring in certain dung beetles, to the frog, pigeon, and guinea pig, found that the larva reencysted. Recently Faust [2] (1927 and 1928), working in Pekin, noted that the larvae of *Spirocerca sanguinolenta* found in a beetle (*Canthon* sp.) reencysted in the mesentery, omentum, parietal wall of the stomach, etc., when eaten by an unproper host, a hedge hog, but developed to maturity when fed to a dog. The presumption that the encysted parasite in the mongoose represents a third-stage larva of a spiruroid which has been introduced into an improper host appears legitimate. Such larvae usually encysted in insects (cockroaches, beetles, etc.) have been repeatedly described but, without recourse to confirmation of the diagnosis by the experimental method, it is both unsatisfactory and undesirable to attempt to identify them specifically or even generically, since in their ontogeny the larvae of different genera exhibit many points of anatomical

[1] Cram, E. B.: Jour. Parasit. (1924), XI, 117.

[2] Faust, E. C.: Migration route of *Spirocerca sanguinolenta* in its definitive host. Proc. Soc. Exp. Biol. & Med. (1927), XXV, 192–194. The life cycle of *Spirocerca sanguinolenta* — a natural nematod parasite of the dog. Science, n. ser. (1928), LXVIII, 407–409.

resemblance (see Seurat 1916).[1] For the convenience of any future reference to the parasite under present consideration, the collective name of Henry and Sizow (1913) [2] for immature Spiruroidea is used in the provisional name, *Agamospirura liberiae*.

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[1] Seurat: Contribution à l'étude des formes larvaires des parasites Hétéroxènes. Bull. Sci. de la France et Belgique (1916), ser. 7, vol. 49, pp. 297–377.

[2] Henry and Sizow: Études des formes larvaires des Nématodes de la famille des Spiruroidea (genre provisoire Agamospirura). Arch. vet. nauk. St. Petersburg (1913), XLIII, 609–637.

XXIX

TYLENCHUS ALATUS n. sp.

By N. A. COBB, Principal Nematologist, U. S. Dept. Agriculture

$$\textit{Tylenchus alatus}\text{ n. sp. } \frac{\begin{array}{ccccc}5. & 12. & -\,19. & \overset{\underline{74}}{\text{M}} & 92.8\end{array}}{\begin{array}{ccccc}2.5 & \underline{3.1}/ & -\,3.5 & 3.5 & 2.5\end{array}}\ 0.53\ \text{mm.}$$

The moderately thick layers of the transparent, colorless, naked cuticle are traversed by three hundred and forty transverse annules, all alike except near the head where they are narrower, and only about a micron across; — through most of the body they are nearly two microns across. These annules, which are not resolvable into secondary elements, are interrupted on the lateral fields by the presence of *strongly-developed wings* (hence the specific name *alatus*), which in the middle of the nema are nearly one-fourth as wide as the body itself. These wings, beginning very narrow near the lips and fading out at full width near the anus on the male, find optical expression as four longitudinal lines, the outer ones being almost as distinctly crenate as the contour of the body; the inner ones, however, more nearly straight and much fainter, and about as far removed from each other as they are from the crenate ones. No series of pores has been seen in the cuticle. Longitudinal "striae," due to the attachment of the musculature, are visible in most regions of the body. The contour of the nema is very distinctly and beautifully crenate. The neck, which is cylindroid posteriorly, becomes convex-conoid anteriorly and ends in a distinctly capitate subhemispherical lip region slightly flattened in front and set off by constriction. The lip region itself is also very finely crenate in contour, the number of very fine diminishing annules (the larger about 0.6 microns) comprising the lip region being perhaps about five. The mouth is not depressed. The amphids, and labial papillae, if any, have not been seen. There are no eyespots. In the single specimen under examination — mounted in glycerine from a preparation in formalin, — the lip region does not show a six-ribbed dome-like framework such as is often seen in triplonchs. Although the lip region is very distinctly set off by a constriction, there is no annule at the constriction more marked than the others. There is a very well-developed, *long, typical* tylenchoid spear, compassing about eighteen annules, with a distinctly three-bulbed base about one-sixth as wide as the corresponding portion of the neck. Anteriorly the spear is guided by a rather long, compound apparatus, which finds its optical expression as, (1) parallel elements, a micron apart, extending back a little farther than the posterior limits of the lip region and probably representing an encircling hollow cylinder one micron in diameter, and, (2) slightly outwardly bowed refractive elements about twice as far back as the base of the lip region, about three microns apart and probably three in number. The emptying place of the dorsal oesophageal gland is visible just behind the base of the spear, as is usual in *Tylenchus*. The oesophageal glands are not very strongly developed. The narrow oesophageal tube leading to the median bulb is strongly cutinized and refractive and is a marked feature of the neck. The ellipsoidal median bulb, very distinctly set off both fore and aft, is a little more than half as wide as the neck and is supplied with a central strongly refractive ellipsoidal valve, 2.8 microns in diameter, — one-fourth as wide as the bulb itself. Behind the median bulb the oesophagus for some little distance is only about as wide as the distance between two of the adjacent annules, *i.e.*, about two microns; thence backward it gradually widens out, however, so that at the base of the neck it is a little more than half as wide as the corresponding portion of the body; the lining of the oesophagus is here very faint, and there is no distinct cardiac swelling. There is no cardia. The beginning of the intestine is quite evident on account of differences in structure, but there is no very obvious constriction between the oesophagus and the intestine. The cells of the intestine are packed with relatively large granules, presumably of a fatty nature, the largest of which are one-fourth as wide as the body; among these are other granules of very, very much smaller size. There is no distinct tessellated effect caused by the arrangement of the large granules of the intestine, but the granules are so large as to impart the peculiar vesicular appearance (irregular pattern) always present in the nemic intestine of tylenchs when the granules are numerous and of large size and highly refractive. This granulation obscures, for the most part, all other details of the intestine. The intestine becomes at once nearly three-fourths as wide as the body, and in the single specimen under examination has much the same structure throughout its length. The body of the male begins to taper, very gently, at a distance in front of the anus somewhat greater than the length of the tail. From the massive raised anus the tail, compassing about twenty-two annules, is conoid to the acute, or subacute, terminus, diminishing rapidly behind the anus so that at a distance from the anus about equal to one-half of the anal body diameter it is only about two-thirds as wide as at the anus. There is a *well-developed transparent bursa*, compassing about forty-two annules, arising laterad very gradually from a point as far in front of the anus as the terminus is behind it, and sufficiently well-developed so that, with the nema in profile, opposite the anus it projects beyond the body contour a distance equal to the corresponding radius of the body. From this point it curves in a uniform convex manner to the terminus. The prominently striated crenate bursa barely includes the tail; its striae coincide with those of the cuticle of the tail. There are two small phasmids(?), or bursal ribs, located at the beginning of the middle fifth of the tail; these extend about halfway to the margin of the bursa and it is quite apparent that they are really *lateral* in their origin. This suggests that they are, possibly, phasmids rather than bursal ribs. The excretory pore lies just behind the oblique nerve-ring. The two equal, arcuate, colorless spicula, — about one and one-fourth times as long as the anal body diameter, — at their widest part, a little in front of the middle, are one-fifth as wide as the corresponding portion of the body, and are only very slightly cephalated by expansion. Their proximal ends lie opposite the body axis. In their posterior three-fifths they taper to a rather blunt point. Seen in profile, they are obscurely falcate in contour. The dorsal contour is almost a uniform curve; yet there is a slight incurvature in the proximal third. On the other hand, the ventral contour has an obvious but slight low projection just a little anterior to the middle. The gubernaculum, closely parallel to the spicula, consists of a single, strongly refractive piece about 1.5 microns thick, and a little more than half as long, and not more than one-fourth as wide, as the spicula; its proximal end is well dorsad of the body-axis. It is possible that there are very minute papillae, ventral or subventral, on the posterior lip of the anal opening. The anterior limit of the single testis is uncertain, but the blind end is believed to be about as far behind the cardiac region as this latter is behind the anterior extremity.

Nothing is known about the female, there being only a single male specimen submitted.

Habitat. Said to be from Cinchona, Africa; submitted by Dr. Sandground, from a collection by Dr. R. P. Strong.

Diagnosis. Distinctly annuled *Tylenchus*, dimensioned as in the formula, with strongly-developed wings, spear, and bursa.

XXX

SPECIAL PROTOZOOLOGICAL STUDIES OF THE BLOOD

By Max Theiler

PROTOZOOLOGICAL STUDIES OF SMALLER ANIMALS IN LIBERIA

The zoological investigations carried out during the Expedition gave special opportunity for the study of parasitic infections of wild animals. Whenever an animal was brought into camp protozoological investigations were undertaken, provided decomposition had not advanced too far. Most attention was given by the writer to the investigation of blood protozoa — which were studied wherever practicable in fresh smears, as well as in Giemsa-stained dried smears. Smears of internal organs, for example, lungs, liver, spleen, and kidney, were also nearly always examined, in infections such as *Haemoproteus* or *Haemogregarines*, in the hope of finding developmental forms. Pieces of these same organs were preserved in fixatives for transportation home for section cutting. In no case, however, have smears or sections of these organs revealed any light as to the life-cycle of the parasites found in the blood. If a species of animal revealed some parasite, great efforts were made to procure other specimens of it, in order to find similar infections and to make as exhaustive a study as possible of the parasite. Thus one of the first specimens of the lizard, *Agama colonorum*, showed a few pigmented intracorpuscular parasites. Examination of the blood of additional specimens of this same lizard showed that quite a number of them were infected with the same parasite which obviously belonged in the genus *Plasmodium*. In all, thirty *A. colonorum* were examined, of which two showed what we interpret as another and distinct species of *Plasmodium* from that which was originally observed. Some of the organisms studied could be identified with species described and named by previous workers. In most cases, however, particularly with organisms of the haemoproteus or haemogregarine type of which knowledge is very meager, we have merely given a very brief description of the parasite and a record of the host. Whenever it has seemed there was sufficient evidence to create a new species, we have done so.

BLOOD PROTOZOA STUDIED IN LIBERIA

- Genus *Plasmodium.*
  - *Plasmodia of Monkeys.*
    - *P. kochi* Laveran, 1899, in *Cercopithecus diana.*
    - *P. cercopitheci* n. sp. in *Cercopithecus nictitans.*
  - *Plasmodium of Bat.*
    - *Plasmodium* sp. in *Petalia grandis.*

Plasmodia of Lizard.
- *P. agamae* Wenyon, 1909, in *Agama colonorum.*
- *P. giganteum* n. sp. in *Agama colonorum.*

Genus *Haemoproteus.*
- *Haemoproteus* sp. in *Gymnobucco calvus.*
- *Haemoproteus* sp. in *Pyromelana hordacea.*
- *Haemoproteus* sp. in *Halcyon senegalensis.*
- *Haemoproteus* sp. in *Melittophagus gularis.*

"Haemogregarines."
- Haemogregarine in the snake *Dendraspis viridis.*
- Haemogregarine in the crocodile *Crocodylus cataphractus.*
- Haemogregarine in the crocodile *Osteolaemus tetraspis.*

"*Grahamella.*"
- *Grahamella in the bat, Petalia grandis.*
- *Grahamella in the rat, Praomys tullbergi.*

PLASMODIA OF MONKEYS

Malarial parasites were seen in two species of monkey, viz. *Cercopithecus diana* and *Cercopithecus nictitans.*[1] Numerous observers have described plasmodial infections in monkeys belonging to the genus *Cercopithecus.* The first organism of this type was seen by Koch.[2] Malarial organisms have been described in *Cercopithecus sabaeus, C. fuliginosus, C. albogularis, C. cephus,* and *C. mona.*[3] This parasite was named *Haemamoeba kochi* by Laveran.[4] According to Wenyon this species is a common parasite of monkeys belonging to the genera *Cercopithecus, Cynocephalus,* and *Cercocebus* in tropical Africa.

Plasmodium of Cercopithecus diana

Three different specimens of *Cercopithecus diana* from three fairly widely-separated localities in Liberia were examined. In each plasmodial organisms were seen which in all probability belonged to the same species. In two, only rare gametocytes were available for study. In the blood of the third monkey, a fairly intense infection was present, but unfortunately this monkey had been dead several hours and decomposition had set in. Different stages in the development of the parasite as observed in the last monkey, are illustrated in No. 400, Figs. 9–13. A study of these figures shows a resemblance to *Plasmodium vivax* of man. There is a tendency for the parasitized red cell to enlarge — but this is not marked. No fully-developed schizonts were seen, nor was there anything resembling Schüffner's dots present. In view of the close resemblance between this organism and the published accounts and figures of *Plasmodium kochi,* we feel that in all probability the specimens of *Cercopithecus diana* which we examined were infected with the same species.

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[1] Plasmodia were also found in *Colobus rufomitratus* in the Belgian Congo.

[2] Koch, R.: Reiseberichte über Rinderpest, Bubonenpest in Indien und Afrika. Tsetse-oder Surra Krankheit, Texas fieber, tropische Malaria, Schwarzwasserfieber. Berlin, 1898.

[3] Wenyon, C. M.: "Protozoology" (1926), II, 969.

[4] Laveran, A.: Les hématozaires endoglobulaires (Haemocytozoa). Cinq. d. l. Soc. Biol. (1899), vol. jub. 124.

Plasmodium of Cercopithecus nictitans

Several specimens of this monkey were examined for blood parasites. In only one, however, was a plasmodial parasite observed. The blood of this animal was examined shortly after death, both in stained and unstained preparations. Exflagellation was observed. The dried blood smears after staining with Giemsa showed a fairly heavy infection with a species of malarial parasite. The large majority of organisms present were ring forms of various sizes. Fairly frequently two dots of chromatin were present. More often the chromatin was in the form of a rod (No. 400, Fig. 5) while sometimes it was U-shaped (Fig. 6). The pigment was bright yellow and in very small particles, usually equally distributed throughout the parasite, but sometimes collected into one or two areas. The parasitized cell was not enlarged, nor were there any changes in the host-cell resembling Schüffner's or Maurer's dots. The gametocytes completely filled the red blood cells and the two types were easily distinguishable. The female gametocyte takes on a deep stain and has a dense and compact nucleus. The microgametocyte stains less densely, in fact often is yellow on account of the large quantity of finely divided pigment, and has a large and diffuse nucleus. Should further study of the malarial organisms of monkeys show that this is a distinct species, we suggest the name *Plasmodium cercopitheci* n. sp.

PLASMODIUM OF A BAT

Although numerous specimens of several species of bats were examined for malarial parasites, in only one was an infection seen. In the blood of this bat (*Petalia grandis*) there was also a sparse infection of trypanosomes and of *Grahamella*. The malarial organisms were fairly abundant. Ring forms, developing schizonts and gametocytes were seen. No segmenting forms were found. The organism is very actively motile, sending out pseudopodia, so that the parasite was usually very irregular in form, and typical ring forms were scarce (No. 400, Figs. 14–20). The infected red blood cell was usually enlarged. Fig. 18 represents a normal red blood cell beside an infected cell for comparison. The staining reaction of the parasitized cells was normal. Chromatin was abundant and very irregular in shape, except in the gametocytes where it took on a round, compact form. Pigment was abundant, dark brown in color and sometimes almost black and in the form of large round or rod-shaped particles, particularly in the sexual forms. Gametocytes were fairly abundant and the two types easily distinguishable (No. 400, Figs. 19–20).

Plasmodia of African bats have been described by several authors. Thus Dutton, Todd, and Tobey[1] found forms resembling *P. murinum* in unidentified bats in the Congo. A species of *Plasmodium* was described by Rodhain[2] in the flying fox *Epomophorus franqueti* from the Ouelle district of the Belgian Congo. The only record we can find of a malarial infection in a bat on the

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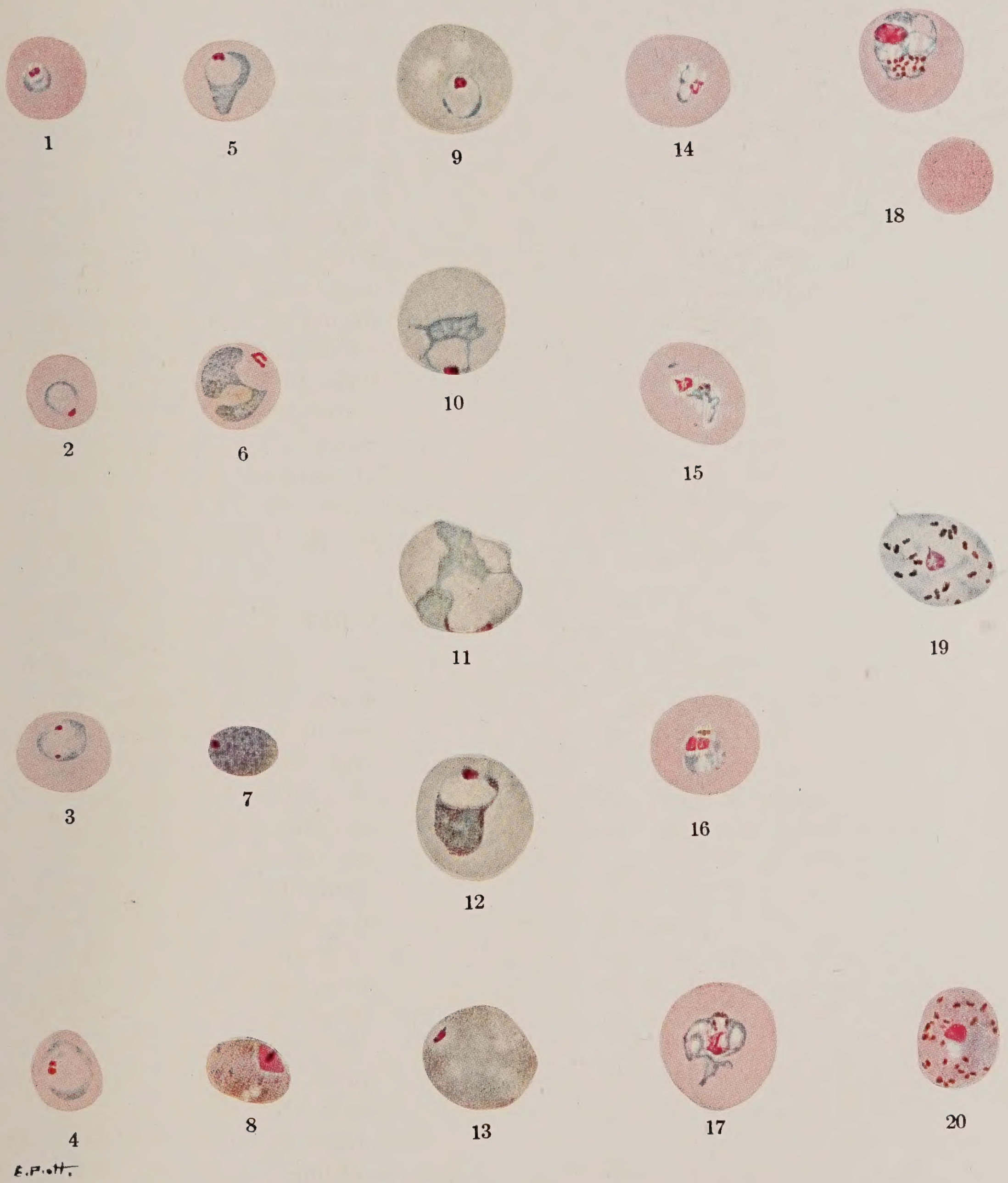
[1] Dutton, J. E., Todd, J. L., and Tobey, E. N.: Liverpool School Trop. Med., Mem. XXI (1906), p. 85.

[2] Rodhain, J.: Bull. Soc. Path. Exot. (1915), VIII, 726.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No. 400 (Figs. 1–20). — Plasmodia from Monkeys and Bat

Figs. 1–8. — *Plasmodium cercopitheci*
Figs. 9–13. — *Plasmodium kochi*
Figs. 14–20. — Plasmodium of the bat, *Petalia grandis*

West Coast of Africa was by A. and M. Leger[1] who described a parasite in the blood of *Epomophorus franqueti*. These authors identified their organism with *Plasmodium pteropi*, a parasite of *Pteropus gouldi*, a flying fox of West Australia. The plasmodium of *Petalia grandis* does not seem to correspond with any of the forms mentioned but in the present incomplete knowledge of the subject we do not feel justified in creating a new species.

PLASMODIA OF THE LIZARD, *Agama colonorum*

Wenyon[2] in the Sudan was the first observer to report the presence of a pigmented organism in the red blood cells of the lizard *Agama colonorum*. At that time he placed this organism in the genus *Haemoproteus*, but as the knowledge concerning pigmented parasites of cold-blooded animals increased, it became obvious that it should be placed in the genus *Plasmodium*. The name for the parasite therefore became *Plasmodium agamae* (Wenyon, 1909).

Todd and Wolbach[3] (1912) recorded the occurrence of a pigmented haemocytozoon in a lizard (*Agama colonorum*) which may be the same parasite. Macfie[4] in Nigeria also saw a pigmented parasite in the lizard.

In the interior of Liberia the lizard *Agama colonorum* is extremely numerous. Microscopical examination of the blood showed that approximately half of these lizards are infected with a pigmented parasite. Study of these organisms showed that there are in reality two species, one of which corresponds to *Plasmodium agamae* Wenyon, and another very much larger. The difference between these two was so distinct that we have no doubt that we are dealing with two species. We propose therefore to call the large species *Plasmodium giganteum* n. sp.

Plasmodium agamae Wenyon

This organism was very common in Gbanga, Liberia. Sometimes it was present alone; at other times in conjunction with *Plasmodium giganteum*. All stages of the asexual cycle were usually present, though in some lizards only the gametocytes were seen. The young schizonts were usually situated toward one end of the red blood corpuscles. The mature schizonts usually had six nuclei. The gametocytes are elongated, halteridium-like bodies, lying beside the nucleus. The host-cell was not altered in any respect, though sometimes the nucleus of the red blood cell appeared to be pushed aside slightly (No. 401, Figs. 8–12).

Plasmodium giganteum, n. sp.

This parasite was observed in the blood from several specimens of *Agama colonorum*. It was quite a rare parasite compared with *P. agamae*. The complete asexual cycle as well as the gametocytes were studied in smears made from the heart blood taken from the lizard immediately after death.

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[1] Leger, A. and M.: C. R. Soc. Biol. (1914), LXXVII, 399.

[2] Wenyon, C. M.: Third Report Wellcome Trop. Res. Lab., Khartoum (1908).

[3] Todd, J. L. and Wolbach, S. B.: Jour. Med. Res. (1912), XXVI, 195.

[4] Macfie, J. W. S.: Ann. Trop. Med. and Parasit. (1914), VIII, 439.

The youngest stages, like *Plasmodium agamae*, are usually situated toward one end of the red blood corpuscle, though they may be located in any part. The mature schizont is very large, often producing a distinct distortion of the red cell. The number of nuclei is very large — at least forty, it being impossible to count them accurately. The gametocytes are very large and of the usual two types, the dark staining macrogametocytes and the light blue microgametocytes. The pigment is golden brown in color (No. 401, Figs. 1–7).

A very noticeable feature is the change in the host-cell. These are usually enlarged and have altered staining reactions. The increase in size was often very noticeable even when the cell was parasitized by a young schizont. The nucleus is often displaced. The alteration in the staining reaction manifests itself by taking on a more purplish tinge than the normal cells. These differences are very well illustrated in No. 401, Figs. 6–7. The differences between *Plasmodium agamae* and *Plasmodium giganteum* may be summarized briefly as follows. *Plasmodium giganteum* is a much larger organism in all stages. The mature schizont contains numerous merozoites, whereas the mature schizont of *P. agamae* typically contains only six. The host-cell infected with *P. giganteum* is very often enlarged, distorted, and has an abnormal staining reaction, and the nucleus is often displaced.

Adler[1] in Sierra Leone studied a specimen of *Agama colonorum* heavily infected with a pigmented haemocytozoon which he concluded was the same species that Wenyon had described as *Haemoproteus agamae* in the Sudan. From Adler's description and his figures, it seems more probable that he was dealing with the same parasite that we found in Liberia and for which we propose the name of *Plasmodium giganteum*, n. sp. According to Adler's account, the mature schizont contained as many as seventy merozoites. Also the nucleus of the host-cell containing the growing schizont was often displaced. Some of his figures show that the red cells are sometimes enlarged, though Adler does not specifically mention this fact in the text.

GENUS *HAEMOPROTEUS*

Parasites which we place in this genus were found in four birds, each of which is considered briefly below.

Haemoproteus in the blood of the barbet *Gymnobucco calvus*

The blood of this bird contained rather a light infection. Only the mature gametocytes were present. Smears stained by Giemsa's method showed clearly the two types of gametocyte, the microgametocyte and the macrogametocyte. The parasites occupy the whole red blood corpuscle, the nucleus of which is displaced to one side and encircled by the organism. The shape of the organism is often almost round, the typical long halteridium forms being also present. This round form of the parasite is in all probability due to changes following the death of the host, as the blood smears were not made immediately after

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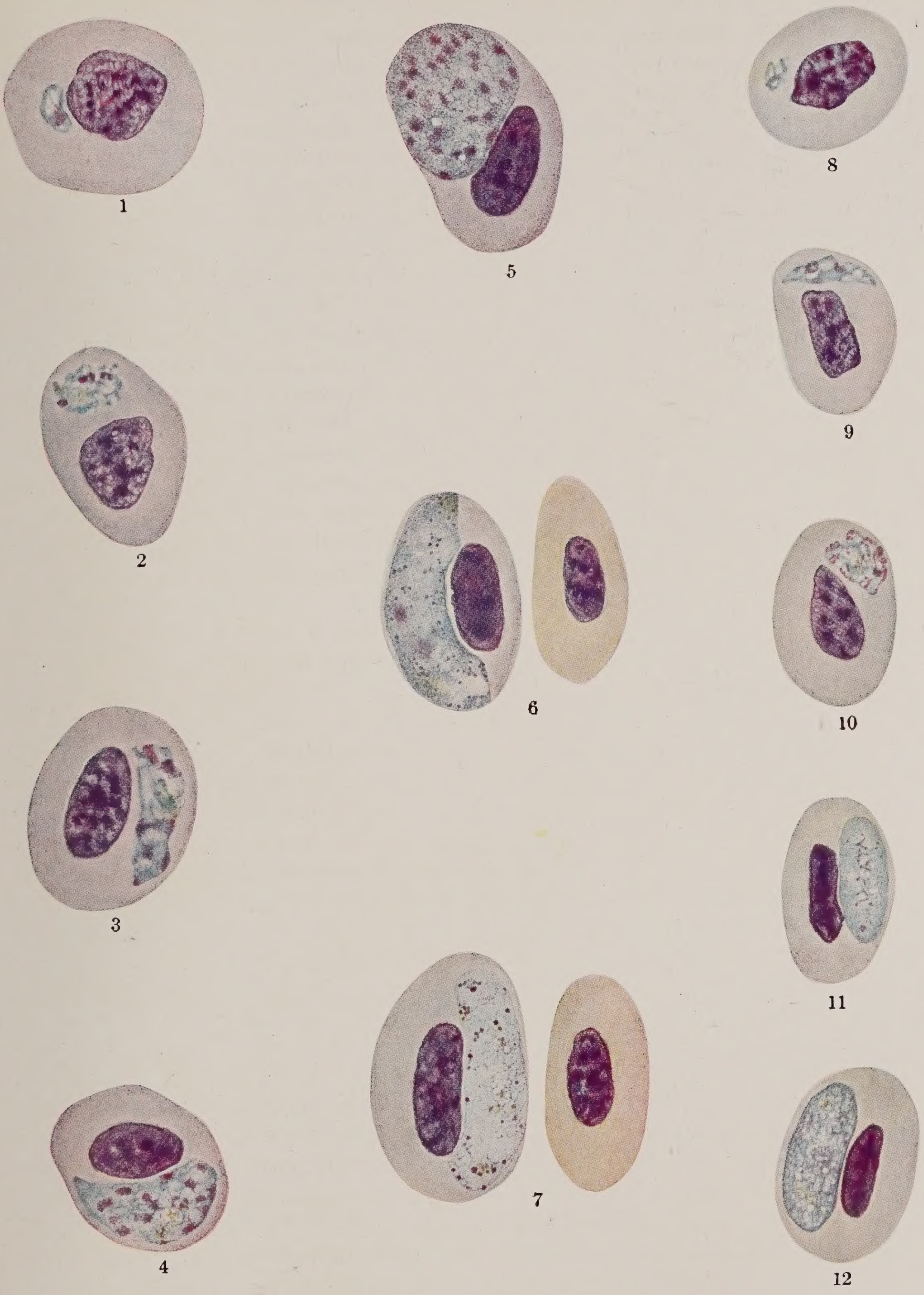
[1] Adler, S.: Ann. Trop. Med. and Parasit. (1924), XVIII, 131.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No. 401 (Figs. 1–12). — Plasmodia of *Agama colonorum*

Figs. 1–7. — *Plasmodium giganteum*
Figs. 8–12. — *Plasmodium agamae*

death. In consequence of the round form of the parasite the host-cell is also distorted in form, losing its oblong shape, tending to become round. Pigment is dark yellow in color and in large granules. We have found no record in the literature of a haemoproteus in this bird.

Haemoproteus of *Pyromelana hordacea*

Various stages of developing gametocytes were present. Mature organisms have typical halteridium-like shape, and occupy almost the entire host-cell, but not to such an extent as in the preceding. The earliest forms seen were small and round without any pigment. Later the parasite became elongated and thin. The pigment was dark brown in color and in large granules.

Haemoproteus of the Kingfisher *Halcyon senegalensis*

The blood of this kingfisher showed a fairly heavy infection of haemoproteus. All stages of the developing gametocytes were present. The mature gametocytes were U-shaped and occupied the greater part of the cell, the nucleus being displaced. The pigment was in fine granules and light yellow in color.

The liver, lung, and other organs were preserved in Zenker's solution. Sections showed no developmental stages of the parasite.

Haemoproteus of *Melittophagus gularis*

The blood of two bee-eaters belonging to the above species showed an infecfection with a haemoproteus. Very few parasites were present and all those studied appeared to be mature gametocytes. The organisms were rather small, halteridium-shaped and occupied approximately one-half of the red blood cell. The nucleus was not displaced. The blood of both birds also showed numerous microfilariae.

Haemogregarine of the Crocodile *Osteolaemus tetraspis*

One specimen of the short-headed crocodile was available for study. This animal was autopsied shortly after death. A preliminary study of a fresh blood preparation revealed a fairly intensive infection with a haemogregarine. In fresh as well as in stained smears, both intracorpuscular forms as well as a few extracorpuscular forms were present. The free forms were about twice the length of a red blood corpuscle, and thin with a blunt anterior end. The intracorpuscular parasites varied in size, some being small and sausage-shaped, while most were large and U-shaped, occupying most of the red blood corpuscle. The nucleus of the host-cell was very often displaced toward one end. Smears as well as sections of the internal organs failed to reveal any developmental forms.

Haemogregarine of the Crocodile *Crocodylus cataphractus*

This crocodile was shot in the Du River and blood smears were made several hours after death. Both intracorpuscular as well as free forms were present in the blood. Compared with the haemogregarine of *Osteolaemus tetraspis*, this parasite was small, being approximately one-half the size of the other. The free forms were still motile fourteen hours after death and were of the usual vermicular form. The intracorpuscular forms were rather short, never U-shaped and resemble very much the Haemogregarines of the alligator, *A. mississippiensis* as figured by Wenyon.[1] They often displaced the nucleus of the red blood corpuscle toward one pole. Smears and sections of the internal organs were normal.

Haemogregarines of Snakes

Haemogregarines were seen in the blood of three specimens of *Dendraspis viridis,* as well as in several unidentified snakes.

The organisms as seen in the blood of *Dendraspis viridis* were of the usual haemogregarine form, *viz.,* large, sausage-shaped intracorpuscular organisms. Smears and sections of the lung and liver showed no developmental forms.

Grahamella

Typical Grahamella were found in one rat, *Praomys tullbergi,* and in one bat, *Petalia grandis.* The infection in the rat was fairly intense, almost every microscopical field showing a parasitized red blood cell. Some of the cells were almost completely filled with these organisms whereas others had only a few.

The infection in the bat was very slight, only a few cells in a smear were found infected. The blood of this bat also showed an intense infection with plasmodia and a mild infection of trypanosomes.

Balantidium of the Monkey *Cercocebus torquatus*

A species of *Balantidium* morphologically indistinguishable from *Balantidium coli* was found in a monkey (*Cercocebus torquatus*). Two other specimens of this monkey examined were negative for this ciliate. During life numerous cysts were passed by the infected animal in its faeces.

At autopsy these ciliates were found in enormous numbers in the large bowel. They were extremely numerous in the caecum. The lower end of the small intestine contained a few. These organisms were particularly abundant in material scraped from the surface of the bowel. There were relatively few in the intestinal contents. The cysts were numerous in the distal end of the large bowel, very few being seen in the upper end.

In addition to *Balantidium,* numerous *Entamoeba,* a blastocystic-like organism and enormous numbers of spirochaetes were present. The entamoebic cysts were of two types. One was large and contained eight nuclei, resembling a large *Entamoeba coli* cyst. The other type was small and contained four nuclei suggesting a small *E. histolytica* cyst. There was no ulceration visible to the naked eye.

Microscopical examination of sections of the large bowel showed no ulceration. The balantidia were present in large numbers closely applied to the surface of the mucous membrane, forming continuous layers in places. Numerous ciliates were seen in the glands of the large intestine. Sometimes as many as three specimens would be present, at the base of the gland, flattening out the epithelium and producing a bottle-like swelling of the gland.

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[1] Wenyon, C. M.: "Protozoology" (1906), vol. II, Plate XIX, p. 1102.

HUMAN TRYPANOSOMIASIS IN LIBERIA

This disease seemed to be fairly well known by the natives of the interior of Liberia. In the Vai language sleeping sickness is known as *konje-kira*, which literally translated is "ball sickness" *i.e.*, enlarged lymph glands. No doubt many cases of enlarged cervical lymph glands are called *konje-kira* though not due to a trypanosome infection. Indeed, several cases in which the enlarged lymph glands were in all probability caused by a pyogenic infection of the scalp were brought to us as cases of *konje-kira*.

Doala Bukere, the originator of the remarkable Vai alphabet, is supposed to have died of this disease (Johnston, "Liberia," vol. II, p. 1114). He developed such extraordinary drowsiness that he often fell asleep while taking his meals. In the Kpwesi dialect the malady is called *ptauli*.

Typical early cases of trypanosomiasis were seen in Bakratown, Nyalai, Betala, and Paiata. Although strenuous efforts were made to find as many cases as possible, only ten cases which were probably trypanosomiasis were found, in five of these the diagnosis was confirmed by finding the causative organism by gland puncture. It is often very difficult in primitive native villages to obtain the confidence of the population. This was, however, not the case when we were searching the country for cases of sleeping sickness. In fact we had very hearty cooperation from the native chiefs, who did their best to locate the cases for us and sometimes walked many miles with a patient. All our cases were in the early stage of the disease. We saw no case in the later stages. The explanation for this is probably due to the fact that when a native becomes very ill he prefers to call in his own medicine-man. This is particularly so in the interior of Liberia where the population has not been in contact with the white man and has therefore no faith whatsoever in his "medicine."

Case A. 6. Bakratown. Boy about eleven years old. Complained of headache and enlargement of glands. All palpable lymph glands enlarged. The posterior cervical lymph glands fill out the back of the neck. Anterior cervical, submaxillary, supra-clavicular, axillary, epitrochlear, inguinal and femoral lymph glands enlarged. Spleen enlarged to an inch below the costal margin. Examination of fresh blood showed auto-agglutination of red blood corpuscles, but no trypanosomes were seen.

A stained blood smear revealed an infection with subtertian malaria.

Puncture of posterior cervical gland showed numerous trypanosomes.

Case A. 20. Boy, seven years old. Patient lives in the village of Nyalai. Posterior cervical, submaxillary and axillary lymph glands enlarged.

Examination of fresh blood showed auto-agglutination but no trypanosomes. The diagnosis was established by the finding of numerous trypanosomes by puncture of the submaxillary lymph gland.

Case A. 24. Girl, about 17 years of age. Betala. Enlargement of posterior cervical lymph glands, otherwise normal. Gland puncture showed trypanosomes.

Case A. 25. Boy, about 12 years of age. Enlarged posterior lymph glands and oedema of lower eye lids. Examination of blood showed auto-agglutination, but no trypanosomes.

Gland puncture revealed trypanosomes.

Case A. 28. Girl, 9 years old. Paiata. This patient showed enlarged posterior cervical lymph glands and oedema of the upper eyelids. Examination of the blood showed auto-agglutination but no trypanosomes. The first gland puncture was negative, but on repetition next day, trypanosomes were demonstrated.

Several other cases from these same villages were brought in as cases of *konje-kira*. Examinations of the blood and gland puncture were negative for trypanosomiasis.

XXXI

SCHISTOSOMIASIS TREATED WITH ANTIMONY SODIUM THIOGLYCOLLATE AND WITH ANTIMONY THIOGLYCOLLAMIDE

By George C. Shattuck

and

Paul T. Willis

Antimony sodium thioglycollate and antimony thioglycollamide have been shown to have a toxicity considerably lower than that of tartar emetic, and have been used successfully in the treatment of granuloma inguinale in the United States by Randall [1] and others.[2]

Believing that these drugs could be used to advantage in other diseases in which antimonials have proved beneficial, the Expedition took with it a supply of them to be tried in schistosomiasis and in African sleeping sickness. To save bulk and weight, and because antimony sodium thioglycollate is not stable in solution, the drugs were put up in powdered form in capsules, which it was believed would protect them sufficiently. Enough sodium citrate was mixed with each dose of the drug to fill the capsule.

In order that dosage might be easily varied without waste of the drug, capsules, containing 0.1 grm. (1½ gr.), and others containing 0.03 grm. (½ gr.) of the drug, were provided. The dose of the two drugs is the same.

The antimonials were courteously supplied to the Expedition free of charge by the manufacturers, Messrs. Hynson, Wescott and Dunning, of Baltimore.

A Case Treated in Liberia

In July, 1926, members of the Expedition discovered at Monrovia a case of vesical schistosomiasis, caused by *Schistosoma hæmatobium.* The child was said to be a "bush girl." Probably she came from one of the interior tribes and contracted the disease there.

Through the courtesy of Dr. Dingwall, who was in charge of the Government Hospital at Monrovia, the patient was admitted to that hospital, and the writers were accorded the privilege of treating her there with intravenous injections of antimony sodium thioglycollate.

The low toxicity of this drug was shown again by an error in the preparation of the solution for the first injection, which was considerably stronger than had been intended. Six doses of from 0.01 to 0.03 grm. were given in the course of twelve days, the total amount being 0.17 grm. The patient received an initial dose of 0.03 grm. in 1.5 per cent solution, instead of 0.01 grm. in 0.5 per cent solution. Several short, hacking coughs were observed while the injection was in progress. In the afternoon the patient's temperature rose to 100.4° F., but dropped to 99° F. in the evening. Subsequent doses of 0.02 and 0.03 grm., given in 0.5 per cent solution at intervals of two days, were not attended by any reaction.

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[1] Randall, A.: Therapeutic Value of two New Synthetic Antimony Compounds in Cases of Granuloma Inguinale. *Journ. of Urology,* 1923, IX, 491. Two New Antimony Compounds for Intravenous Use. *Amer. Journ. Med. Sci.,* 1924, CLXVIII, 728.

[2] Shattuck, G. C.: Treatment of Inguinal Granuloma with Thioglycollates of Antimony. *Amer. Journ. Trop. Med.,* 1926, VI, 307.

Frequent examinations of the urine during the course of treatment showed a diminution of ova from 2.8 per field to 1 in four fields. After the sixth day, moreover, the ova showed evidence of degeneration. The urine, blood-tinged at first, improved in appearance, until only a few red blood corpuscles could be found with the aid of the microscope.

After the twelfth day the patient could no longer be kept in the hospital and was discharged apparently well. It proved impracticable to complete the course of treatment, or even to follow up the case outside the hospital.

Notes on Case

Girl, age 6 years, colored, born probably in the interior.

Admitted to Government Hospital, July 23, 1926.

Present Illness. The child is said to have had hematuria, frequency of micturition, and pain for about three years. She has had several attacks of fever, probably malarial, but has generally been able to keep about.

Physical Examination. Nothing important found.

Urine. Blood-tinged. The sediment showed many red blood-cells, and ova of *Schistosoma haematobium*. Examination of thirty fields showed an average of 2.7 ova per field.

Blood. July 24, 1926. Red cells appear normal. One tertian malarial parasite seen after prolonged search.

Dosage of antimony sodium thioglycollate: —

First day	0.03 grm.
Third day	0.02 "
Fifth day	0.03 "
Seventh day	0.03 "
Ninth day	0.03 "
Twelfth day	0.03 "
Total	0.17 grm.

Egg Counts (average of thirty fields): —

Second day	2.8	
Third day	2.5	
Fourth day	2.7	
Fifth day	1.7	
Sixth day	1.2	degenerating
Seventh day	1.5	"
Ninth day	0.5	"
Twelfth day	0.25	"

Cases Treated in the Belgian Congo

In January, 1927, the Expedition left with Dr. C. C. Chesterman, of the Yakusu Mission, near Stanleyville, on the Congo, a supply of sodium antimony thioglycollate, and also some antimony thioglycollamide. Samples of the drugs were examined by Messrs. Hynson, Wescott and Dunning, after having been carried for more than a year in Africa, and were reported on September 26, 1927, to have undergone no deterioration.

Trial of the drugs in the treatment of schistosomiasis at Yakusu was entrusted by Dr. Chesterman, during his absence, to Dr. K. Waller Todd. A letter from Dr. Todd, dated February 10, 1928, gave a brief preliminary report indicating prompt and favorable effects of the drugs, and no accidents, in a score of cases of schistosomiasis, but he reported that some of the drugs finally appeared to be changing. He forwarded samples of each drug to be tested, and these were sent immediately to Messrs. Hynson, Wescott and Dunning for examination. They reported on April 13, 1928, that the samples of both drugs had undergone decomposition.[1] A subsequent letter from them states that the *solution of antimony thioglycollamide* (which they market in 0.4 per cent solution in ampoules ready for use) "is indefinitely stable, and would very probably be satisfactory for use in the tropics, but the antimony (sodium) thioglycollate solution undergoes gradual decomposition within a comparatively short time."

Conclusions

(1) Antimony sodium thioglycollate seems to have had a markedly beneficial effect in a case of schistosomiasis, in which it was used by the writers in Liberia.

(2) Antimony sodium thioglycollate and antimony thioglycollamide were both tried in schistosomiasis by Dr. K. Waller Todd, at the Yakusu Mission in the Belgian Congo. A preliminary report from him indicates prompt and favorable action by both drugs, and no accidents.

(3) The drugs put up in powdered form in capsules withstood the climate of tropical Africa for more than a year, but some of them finally deteriorated.[1]

(4) Antimony sodium thioglycollate in solution soon begins to decompose, but the solution of antimony thioglycollamide, which is marketed in ampoules by the manufacturers, is believed by them to be stable, and to be suitable for use in the tropics. Antimony thioglycollamide in powder is probably stable when not mixed with sodium citrate.

(5) Because of its relatively low toxicity, and because of the success with which it has been used in granuloma inguinale, and thus far in schistosomiasis, it seems probable that antimony thioglycollamide can be used effectively and advantageously for the treatment of the various tropical diseases in which antimonials have proved useful.

[1] The deterioration was attributed to the presence of the sodium citrate which was mixed with the antimonials in the capsules.

FURTHER USE OF ANTIMONY THIOGLYCOLLAMIDE IN BILHARZIASIS AND IN TRYPANOSOMIASIS

By George C. Shattuck

The value of antimonials in the treatment of bilharziasis, of leishmaniasis, of inguinal granuloma, and to a less degree in African trypanosomiasis, has long been recognized. Tartar emetic has generally been used because it is cheap and because the newer antimonials, in general, have not given results which are strikingly better, but, in the treatment of inguinal granuloma in man, the use of antimony thioglycollamide has seemed to me to have decided advantages. Rowntree and Abel[1] demonstrated its relatively low toxicity for animals and it has appeared to be less toxic for man than is tartar emetic.[2] It seems also more efficient for the treatment of inguinal granuloma than is tartar emetic and it has the further advantage that intramuscular injections in suitable dilution, and in the lower scale of dosage, may cause no painful reaction in some individuals, and but mild local reactions in other persons.[3]

Attention was called in an earlier paper[4] to the use of these drugs for bilharziasis. It is now possible, through the courtesy of Dr. Clement C. Chesterman, Director of the Yakusu Hospital (Haut Congo Belge) of the Baptist Missionary Society, and of Dr. K. Waller Todd, who had charge of the hospital while Dr. Chesterman was on furlough, to publish some additional data not only on the use of the triamide of antimony in the treatment of bilharziasis but also in human trypanosomiasis for which it was recommended for trial by Rowntree and Abel on the basis of efficiency in experimental trypanosomiasis in animals.[5]

All of the cases reported below were under the care of Dr. Todd and I am indebted to him for the data.

Bilharziasis

Dr. Todd's fourteen cases of intestinal bilharziasis were caused by *Schistosoma haematobium*, or, at any rate, by a schistosome producing an ovum having a terminal spine. Dr. Chesterman[6] has called attention to the fact that, at Yakusu, these ova are found in the faeces and not in the urine.

Dr. Todd was disappointed at not being able to follow up the cases with an adequate number of stool examinations at intervals. It proved impossible, as a rule, to obtain specimens of faeces from patients after they considered themselves well. Moreover, they generally failed to return after the symptoms had abated, so that thorough treatment was not practicable. One relapse only is known to have occurred. The injections, as a rule, were given intravenously.

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[1] Rowntree, L. G. and Abel, J. J.: Jour. of Pharmacol. and Exper. Therapy, 1910–11; Vol. 2; p. 101, and *Ibid*, p. 396, and *Ibid*, p. 501.

[2] Randall, Alexander: Jour. of Urology, 1923; Vol. 9; p. 491, and Amer Jour. Med. Sciences, 1924; Vol. 168; p. 728.

[3] Shattuck, G. C. et al: Amer. Jour. of Trop. Med., 1926; Vol. 6; p. 307.

[4] Shattuck, G. C. and Willis, P. T.: Jour. Trop. Med. and Hyg., 1928; May 15th.

[5] Rowntree and Abel: *Loc. cit.*

[6] Chesterman, C. C.: Ann. Soc. Belge de Méd. Trop. Brux., 1923; Vol. 3; p. 73.

Table I epitomizes the records of fourteen cases. The number of doses taken by each patient is strikingly small. The average number of doses was slightly less than four. The total dosage is likewise very low, even when the ages of the patients are allowed for; and, lastly, the duration of treatment was very short in most cases.

"Manson's Tropical Diseases" (8th edition, p. 491) recommends for adults a total dosage of twenty-five to thirty grains of tartar emetic or about two grams, to be administered over a period of from four to six weeks. This recommendation follows Christopherson closely; but Table I shows that Todd's largest total dose was less than half a gram and his longest period of treatment was twenty-four days. Todd's shortest recorded period of treatment was four days and the total dose in this case was only 0.11 grams, but, even in this case, apparent cure resulted.

TABLE I

BILHARZIA CASES

Case No.	*Age*	*Sex*	*No. of Doses*	*Total Dose*	*Dura. of Treatment*	*Result*
I	16	M	3	0.11 Gm.	4 days	Symptomatic cure. Single stool negative 1 month later.
II	27	F	5	0.29 "	8 " *	After 4th dose on 6th day of treatment ova still abundant.
III	10	M	4	0.19 "	14 "	Appeared well 7 mos. later.
IV	13	F	9	0.46 "	24 "	Stool negative after 10 days of treatment. Stool negative 1 wk. after treatment.
V	20	M	3	0.22 "	10 "	Stool negative after treatment. Appeared well 2 mos. after treatment.
VI	8	F	4	0.13 "	.....	Appeared well 5 mos. after treatment.
VII	20	F	3	0.15 "	.....	Appeared well 5 mos. after treatment.
VIII	8	F	4	0.10 "	.....	Constipated 3 wks. after treatment.
IX	11	M	2	0.08 "	.....	Appeared well 5 mos. after treatment.
X	17	M	4	0.28 "	.....	Robust health noted some time after treatment.
XI	12	F	4	0.20 "	.....	Appeared well after 2nd injection and 2 mos. after treatment.
XII	19	M	4	0.29 "	18 days	Appeared well 9 days after treatment.
XIII	25	M	3	0.16 "	.....	Diarrhoea practically ceased after first dose.
XIV	20	M	3	0.10 "	.....	Stool negative 5 days after treatment and patient appeared in excellent health 2 mos. later.

* Treatment was discontinued because of "pain in legs accentuating old arthritis *but with oedema of feet.*" Subsequently treated with tartar emetic with good results. It seems unlikely that the triamide caused the pain or the oedema of the feet.

Table I shows that improvement in, or disappearance of, symptoms appeared promptly in most cases. Case 2 was exceptional in that ova were still abundant after eight days of treatment.

Toxic symptoms, clearly attributable to the drug, were observed only in Case 5 after he had received the large initial dose of 0.10 gram. On questioning he then complained of headache.

Trypanosomiasis

Six cases of human trypanosomiasis received antimony thioglycollamide but, owing to the fact that they had been treated not long before with other drugs, it is difficult to interpret the therapeutic results.

Three of the cases were given antimony because partial blindness had followed treatment with arsenicals. The fourth case had albuminuria after two doses of "Bayer 205." In these four cases the dosage of the antimonial was small and no symptoms were caused by the drug.

The fifth case, a male of about nineteen years of age showing "advanced nervous symptoms but no sleepiness," received 0.54 gram of the drug in seven days. Ill effects were first noted after the last injection. Trembling started within one minute and lasted for several hours. Three days later shallow ulcers appeared on the tongue and the general condition of the patient was worse. Ulcers on the tongue are not a generally recognized sign of antimony poisoning and I do not remember having seen them previously recorded as such. In this case the total dosage is larger than would ordinarily be used during the first week of treatment for bilharzia with tartar emetic. Tolerance to antimony may be expected to increase gradually but caution should be exercised at first.

In the sixth case a combined treatment was begun with thioglycollamide and tryparsamide which were adminstered on different days.

Summary

1. Antimony thioglycollamide used in the treatment of fourteen cases of bilharziasis of the bowel (*Schistosoma haematobium*) gave prompt symptomatic relief except in Case No. 2, and apparent cure resulted from its use except in Case No. 2 and in one other case which returned with a relapse.

2. These results were attained although the individual doses, the total dosage, and the duration of treatment were strikingly low in the reported cases.

3. Adequate follow-up by stool examination was not possible, but many of the patients appeared to be well from two to six months after treatment, and stool examinations made in a few of the cases after treatment were negative.

4. A man of twenty who received an initial dose of 0.10 gram, on questioning, said he had a headache for one day thereafter. Such an initial dose of tartar emetic might have been expected to cause more severe symptoms.

5. Antimony thioglycollamide was adminstered in six cases of trypanosomiasis. In one of these cases heavy dosage was employed during the first week and symptoms of toxic nature were produced (fifth case).

6. Should more complete information confirm my impression that antimony thioglycollamide is more effective in equal dosage and also somewhat less poisonous for man than is tartar emetic, the former drug will become valuable for the treatment of bilharziasis and perhaps also for certain classes of cases of human trypanosomiasis.

7. A therapeutically active antimonial of low toxicity would seem to be indicated in trypanosomiasis as follows:

(a) for persons unusually susceptible to arsenic
(b) for cases in which symptoms of arsenical poisoning have appeared
(c) for trypanosomes which have become arsenic-fast
(d) for use between courses of arsenicals or in conjunction with other medication.
(e) for cases resistant to other forms of medication

No antimonial has yet been found effective in the later stages of the malady when the nervous system has been extensively invaded by the parasites.

8. It is believed that the manufacturer's solution of antimony thioglycollamide in ampoules is indefinitely stable but it has the disadvantage of being expensive. Expense can be minimized by obtaining the drug in powder form and by making up the solution as needed according to instructions which can be obtained from the manufacturer.[1] The pure powdered drug is believed to be stable.

9. Dr. Chesterman, having tried a number of the newer antimonials without finding in them any striking advantages over tartar emetic, is skeptical of the value of antimony thioglycollamide. Dr. Todd, while noncommital at present, believes the drug worthy of further trial. I think that Dr. Todd's results in bilharziasis, together with the findings of Randall and of Shattuck referred to above, justify the hope that antimony thioglycollamide may, ultimately, prove of greater value than other antimonials now available.

DRINKING WATER FOR TRAVELLERS IN THE TROPICS

By George C. Shattuck

When plans were being made for the "Harvard African Expedition," which was to consist of a party of eight whites, it was realized that the most varied water problems would be encountered, and that it would not be easy to boil enough water for a party of this size. It seemed desirable, therefore, to provide for chlorination of larger and of smaller quantities of water as need might arise.

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[1] Messrs. Hynson, Westcott & Dunning, Pharmaceutical Laboratory, Baltimore, Maryland, U. S. A.

CONTAINERS

The Lyster bag, which is provided for the United States Army, could not be obtained on the market, but, through the courtesy of the War Department, two bags were assigned to the Expedition for experimental use. The bags had a capacity of about thirty gallons (120 liters each). They were made of khaki-colored rubber cloth, and were provided with spigots. Each bag had a device for hanging it up and a canvas cover which was held in place by snap-buttons. One of the bags was in constant use by our party while in Monrovia, where it hung upon the veranda of the house in which we lived, and at base camps in the interior the bags proved invaluable. We figured on one gallon (4 liters) per day per man. At this rate one bag holding thirty gallons (120 litres) would easily provide water for eight men for three days.

When the party was split into sections, and when camp was being moved daily, the Lyster bags were not used because unnecessarily large. Under these circumstances a four-gallon (16 liters) desert water bag was filled and chlorinated daily while camp was being made. This sufficed for camp needs in the afternoon and evening and for filling the canteens on the following morning. Chlorination in the canteen was also possible, so that each member of the party could provide himself at all times with potable water.

When travelling on a river steamer on the Congo, and while staying in a hotel at Stanleyville, water was chlorinated in a desert bag and in carafes for table and bedroom use as well.

For two or three on safari it was then comparatively easy to boil water enough for drinking by devoting to this purpose a large water kettle. An iron bucket provided with a cover and a lip for pouring would have been preferable, because a kettleful of water was only enough to fill two canteens.

A number of small covered pots and some tins of "solid alcohol" were available for boiling water, but we did not use them because chlorination in the carafe proved easy and satisfactory.

CHLORINATING SUBSTANCES

Chlorinating substances were provided for the Expedition in four forms, as follows: —

I. Calcium hypochlorite powder in amber glass ampoules, prepared for the United States Army.

II. Calcium hypochlorite in the form of "water sterilizer tabloids" (each equivalent to 1 gr. or 0.065 grm. of chlorine), of Burroughs Wellcome & Co.

III. Calcium hypochlorite powder in small vials having rubber stoppers and sealed with paraffin.

IV. Halazone tablets — Abbott Laboratories, Chicago.

(I) Directions for use of the Army equipment are given in a printed notice which is attached to the inside of the carrying case of the Lyster bag. The directions read as follows: —

Directions for Use.

(1) Set up the bag, adjust cover and strain in the water to within about four inches of the top, using the gauze provided as a strainer.[1]

(2) Get a clean stick or something of the kind for stirring the water. Place it down in the water and let it stay; do not take it out at any time.

(3) The treatment of the water consists of adding the contents of tubes of calcium hypochlorite (lumpy powder in brown glass tubes), testing the water in an ordnance cup with orthotolidine (0.1 per cent solution in ten per cent hydrochloric acid), which is a liquid in vaccine ampoules, then when the right colour is obtained, waiting thirty minutes and adding sodium thiosulphate to remove the excess of chlorine and destroy its odour and taste.

(4) The method is as follows; carry out each step carefully: —

(*a*) Fill an ordnance cup about half full with water from the bag. (*b*) Take one of the brown glass tubes of calcium hypochlorite, break it while holding it over the cup and dump its contents into the cup. Stir the powder into the water with a spoon and pour the water from the cup into the bag. (*c*) Stir the water in the bag thoroughly, then run three cupfuls through one of the faucets and pour the water back into the bag. (*d*) Draw off a cupful of the water through the same faucet. Fill the cup to within half an inch of the top. (*e*) Break the tip off one of the ampoules of orthotolidine and shake the fluid into the cup of water. (This is a clear fluid in a tube such as those used to contain typhoid vaccine.) Stir this up in the water, using another clean, dry spoon. (*f*) As the water is stirred it begins to turn yellow. This yellow colour tells by its intensity whether or not enough tubes of calcium hypochlorite have been added. One may be enough, but it may take two or three, or even ten or more. It is necessary to add them one at a time, testing between, until the yellow colour deepens quickly to a distinct orange, or orange-red colour. A lemon or canary yellow means less than enough, and another tube must be stirred up in a cup of water and added to the bag as before. (*g*) If the colour is lemon yellow, fill another cup half full of water, break another tube of calcium hypochlorite into it, stir it up and pour it into the bag. Stir the water in the bag, wash out one of the faucets three times, then fill the cup and shake into it the contents of an ampoule of orthotolidine. Stir with a clean, dry spoon as before and look for an orange or orange-red colour. If the colour is only a lemon yellow, again, at the end of about a minute, put in another tube of calcium hypochlorite, and keep doing this until the test no longer shows a lemon yellow, but gives an orange or orange-red. (*h*) When the orange or orange-red colour comes up, enough calcium hypochlorite has been added and the water will be ready to drink in thirty minutes. Take the time and prepare the solution which removes the excess of chlorine — the chlorine gives the water its peculiar odour and taste — from the water. (*i*) This neutralizing material is sodium thiosulphate, and it is supplied as crystals in clear glass sealed tubes. Fill an ordnance cup with water, break one tube and shake the crystals into the cup. Stir with a spoon to dissolve and let this cup stand until the thirty minutes are up. (*j*) At the end of about twenty or twenty-five minutes begin washing out the faucets. Run five cupfuls of water through each and pour the water back into the bag. (*k*) At the end of thirty minutes pour the dissolved sodium thiosulphate into the bag and stir the water thoroughly. (*l*) The water is now ready for drinking.

It early became apparent that the calcium hypochlorite was deteriorating rapidly, even in the Army ampoules. They generally exploded when opened by filing, with the result that much chlorine escaped and more or less of the powder was scattered and lost.

At Monrovia, in Liberia, between July 10 and 30, 1926, we used rain water which had been collected from a roof and stored in a cistern. This water was clear, but of course not free from impurities. To get a positive test for adequate chlorination, it was necessary to add to this water calcium hypochlorite at the rate of three or four ampoules to the full bag (30 gallons, or 120 liters). Even larger quantities were needed as time passed.

On July 24, 1926, the other Lyster bag was put to use at a base camp on the

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[1] We used Canton flannel instead of gauze.

Dukwia River (Firestone Plantations Company "Du No. 3"). The river water at that time was slightly cloudy and *ten ampoules* of calcium hypochlorite were required to give a test for adequate chlorination in thirty gallons of water. When, after rain, the river water became more turbid, twelve or fifteen ampoules would be required to give a faint taste of chlorine, but tests with orthotolidine did not even then show an adequate excess of chlorine. At this rate the supply of Army calcium hypochlorite would very soon have been exhausted had its use been continued.

The turbidity of the water was probably caused by very finely-divided mineral matter, but, even after rain, there was very little sediment on standing.

(II) Burroughs Wellcome & Co.'s tabloids of "chlorinated lime" were then tried. Directions are provided with their "water sterilizer." They specifically do not recommend this product for use in the tropics. We were not surprised, therefore, to find evidence of early deterioration in their calcium hypochlorite. The tablets served well for a month, and less well for several months longer, but increasing numbers of tablets had to be added until the water toward the bottom of the container became milky with lime. Within a few weeks the bottles began to pop when opened. Later, liberation of chlorine within the bottles lifted the cork stoppers and cracked the paraffin sealing. Finally, the tablets turned grayish and became soft. At this stage they were practically inert.

The Burroughs Wellcome and Co. test tablets of potassium iodide and starch soon began to give results which were at variance with those of the orthotolidine test. Both tests were soon abandoned in practice, and we came to rely instead upon the *taste* of chlorine. At the same time we entirely discontinued dechlorination of the water, because the taste of chlorine was not seriously objectionable and this evidence of its presence gave an added sense of security.

On account of the difficulty of adequately chlorinating turbid water, we came to rely more and more upon boiling any water which was not clear.

(III) The calcium hypochlorite which we had packed in vials with rubber stoppers sealed with paraffin was not used. When examined after eighteen months (the Expedition had returned home meanwhile) it was found that all the stoppers had become loose, that some had fallen out, and that the cigarette tin in which the vials had been packed was badly damaged by rust. Doubtless the corks had been loosened by decomposition with gas formation within the vials.

(IV) The halazone tablets were very useful in Liberia for chlorinating water in canteens while on the march. In the Belgian Congo they were again used for chlorinating filtered water in carafes upon river steamers and at the hotel at Stanleyville. Three or four tablets from a recently opened bottle regularly gave a strong taste of chlorine when added to a quart of clear or filtered water. While on safari in the Eastern Province of the Belgian Congo, the water encountered was generally so turbid as to render chlorination unsatisfactory. Consequently, boiling was regularly practiced there. It was not difficult, because the party had been divided into sections which travelled separately.

Some of the halazone tablets were extremely friable when packed and others were very hard. The latter did not dissolve readily, so that it became necessary to powder them by folding the tablet in paper and striking it with a knife-handle. The powder was then added to the water and mixed well by shaking.

Dakin and Dunham[1] originated the use of halazone for the sterilization of drinking water, and they gave the substance this name. The chemical name of the active chlorinating substance is para-sulphonedichloramidobenzoic acid and the formula is $C_6H_4(SO_2NCl_2)COOH$–1: 4. The tablets recommended by Dakin and Dunham weighed 100 to 105 mg. and contained four per cent of the acid above mentioned, four per cent of sodium carbonate and ninety-two per cent, or slightly more, of sodium chloride. They found such tablets to be more stable than other similar compounds known to them. When kept in amber-colored bottles under ordinary conditions no decomposition was noted in two months. Such a tablet is manufactured by the Abbott Laboratories, of Chicago. The Monsanto Chemical Works, of St. Louis, also manufacture halazone, but I have had experience only with that of the Abbott Laboratories.

Tests made by Dakin and Dunham indicate that the acid in the tablet above described, when used in a "concentration of 1: 300,000, is sufficient to sterilize an ordinarily heavily contaminated water in about thirty minutes." They observed, further, that this concentration gives a taste of chlorine which is just perceptible.

One tablet added to a quart (or liter) of water gives a concentration of the acid of about 1: 250,000 and, because the acid contains about twenty-five per cent of available chlorine, a proportion of chlorine of about 1: 1,000,000 is obtained if the tablet be of full strength.

Because deterioration of halazone through exposure to air under tropical conditions had been feared, our halazone was packed in vials containing only twenty tablets each. These vials were well corked and sealed with paraffin. Eighteen months later, and after a year in tropical Africa, the corks of unused bottles were still in place and the sealing intact.

That the moderate excess of tablets used by us to give a strong taste of chlorine in the Congo water was required by impurities in the water, and not by deterioration of the tablets, is indicated by the fact that subsequent analyses of tablets from two of our vials showed no evidence of appreciable deterioration (see Mr. Clark's analysis below).

Although strong solutions of chlorine may corrode metals, the low concentrations required for the sterilization of water are not likely to injure vessels such as galvanized iron buckets or aluminium canteens. Therefore, such metal containers may be used for water which is in process of chlorination or which has been chlorinated.

TEST ANALYSES

The results of his chemical analyses were kindly reported on October 31, 1927, by Mr. H. W. Clark, of the Department of Public Health of the Commonwealth of Massachusetts. Mr. Clark says: "Both solid and disintegrated tablets were examined. The solid tablets contained one per cent of available chlorine and the disintegrated tablets slightly more than this." Inasmuch as the tablet originally contained four per cent of the acid which is the active chlorinating substance, and, inasmuch as this acid should contain about twenty-five per cent of available chlorine, there seems to have been no appreciable deterioration of the halazone.

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[1] *Brit. Med. Journ.*, Vol. i, p. 682, May 26, 1917.

Mr. Clark's report upon the Army ampoules of calcium hypochlorite is in contrast to these findings. Of the two samples tested, he said: "The first contained 13.7 per cent, and the second 14.4 per cent of available chlorine," whereas "chloride of lime contains practically 34 per cent available chlorine; hence this material had decomposed and, in fact, when the ampoules were opened they exploded with loss of chlorine."

Mr. Clark reported on the ampoules of sodium thiosulphate as follows: "Two samples analysed. The material had lost some water of crystallization but was of full strength."

Regarding the orthotolidine, he said: "Two ampoules were broken open and poured into 50 c.c. of distilled water each. Chlorine water added to faint yellow colour required 0.03 c.c., which is equivalent to 0.008 part chlorine in 100,000 in both cases. Good quality."

Of Burroughs Wellcome & Co.'s tabloids of potassium iodide and starch, after describing his tests, he remarked: "It is evident there has been some decomposition of this mixture, as would be expected."

Schistosomiasis

It is well known that the cercariae of *Schistosoma* which fail to find a host do not long survive, and that water containing them, if free from infected snails, becomes safe within less than 48 hours. Similarly, it is known that the cercariae are killed in a short time when the water has been heated to 50° C. (122° F.). To be quite safe, it is well to have the bath water heated to 60° C. (140° F.).

I have no information about the effect of chlorination upon cercariae, and do not know whether water treated as above described with chlorinating substances is safe for drinking in a district where schistosomiasis is found. When in doubt we boil the drinking water (see also page 229 of this Report).

Turbid and Muddy Water

Since returning from Africa I have discussed the problem of clarifying drinking water in the field with Dr. Milton J. Rosenau, Professor of Preventive Medicine and Hygiene, of the Harvard School of Public Health. He proposed the following procedures: —

A. (1) Let the water stand for an hour or more. Then pour it off, leaving behind the mud which has settled to the bottom.

(2) Strain through several layers of cloth, *e.g.*, Canton flannel.

(3) Filter through Berkefeld candle by means of a *pressure* pump.

When this process has been carefully performed in a cleanly manner, neither boiling nor chlorination would be necessary.

The Berkefeld candle is cleaned by scrubbing or scraping the inner or outer surface and by reversing the current of water through it. It could be freed of organic matter if necessary by putting it in the fire, and it could readily be sterilized by boiling.

B. If preferred, alum could be used to precipitate the mud. Either potassium or ammonium alum would serve. One grain of alum to the gallon of water might be sufficient for slightly turbid water. A muddy water may need 7 to 8 gr. A slight excess of alum can be tasted but does no great harm. The amount of alum required depends upon the turbidity and reaction of the water and must be determined by trial in each case.

Peaty water may be slightly acid, and might require the addition of a little calcium hydroxide (lime) or sodium carbonate to render it alkaline in order to obtain precipitation by the alum.

Mr. Melville C. Whipple, Assistant Professor of Sanitary Chemistry, of the Harvard Enginering School, told me that he believed a Berkefeld filter coarse enough to be of practical use in the field would still be so fine as to become clogged inside with fine silt which could not be easily removed from the pores of the filter.

Mr. Whipple thought that some chemical method would be more practical and advised the use of alum. Aluminium sulphate, he said, has certain advantages, but should not be chosen for use in the field because it tends to absorb moisture. Crystalline [1] potassium or ammonium alum would serve.

The amount of alum necessary would depend upon the turbidity of the water. The exact amount required in the special instance would have to be determined by trying it. The precipitate, fine at first, should be fully formed within an hour. Water having only a slight turbidity could be clarified by the addition of one grain of alum per gallon of water, but very turbid water might require six to eight grains per gallon. A very turbid, soft water might require the addition of so much alum as to render it slightly acid. It would then be necessary to alkalinize the water in order to obtain proper precipitation. For this purpose a small quantity (about one-third grain per gallon for each grain per gallon of alum) of sodium carbonate (washing soda) or of calcium hydroxide (lime) could be added. Hard waters are sufficiently alkaline and therefore would not require the addition of an alkali.

Precipitation by alum goes on satisfactorily in cold water. The reaction can be speeded up by heat. The water may be brought to a boil, but, should it be kept boiling, the precipitate would be broken up. The process of precipitation in heated water can be completed in a few hours. In cold water precipitation would certainly be complete after standing over-night.

The use of alum would not interfere with subsequent chlorination, or with the use of a Berkefeld filter, provided that the alum precipitate was first allowed to settle.

Most if not all the turbid water which we encountered in Liberia and in the Belgian Congo was hard, and therefore would not have required the addition of an alkali had alum been used to clarify it.

[1] Powdered alum might cake, but its use would not be objectionable.

Summary

While travelling in Liberia and in the Belgian Congo with a party of seven or eight whites, the problem of supplying safe drinking water was ever present. Boiling and several methods of chlorinating were tried. Boiling was generally preferred when clear water was not available, because the turbid water neutralized a large amount of chlorine.

For the purpose of chlorinating clear waters three methods of using calcium hypochlorite were tried. All were found unsatisfactory because of rapid deterioration of the calcium hypochlorite, even when packed in amber glass ampoules.

Halazone, on the other hand, proved sufficiently stable for practical purposes — a fact of great importance for the traveller.

Although the Expedition, numbering eight whites in Liberia and seven in the Belgian Congo, spent about a year in tropical Africa, no member of it contracted dysentery or suffered from severe intestinal diarrhoea.

In parts of Africa during prolonged dry seasons the only water available may be excessively muddy. Under these circumstances Mr. Whipple's recommendations for clarification of water, as described above, would probably prove practical and satisfactory. Few persons would have the patience to make use of more time-consuming procedures. If alum were used only when necessary, a few pounds would go a long way. Probably preliminary alkalinization of the water would seldom be necessary in Liberia or in the Belgian Congo.

XXXII

BOTANICAL REPORT OF LIBERIA[1]

By David H. Linder

Liberia is situated between 4° 22′ and 8° 50′ north of the Equator, in the widest part of the forest belt that borders the Gulf of Guinea. The country is relatively low, rising from sea level at the Gulf of Guinea, to approximately 1500 feet in the interior near Bakratown. It is reported, however, that the elevation becomes somewhat greater further into the interior near the French Guinea border. The land rises gradually as one proceeds northward by a series of rolling hills which appear to run in a very irregular manner, parallel to the coast. These hills are cut by the larger rivers, such as the St. Paul and St. John, which are fed by numerous brooks and streams that drain the minor valleys, as would be expected in a country so well supplied with tropical rains. Because of the hilly nature of the country, and the fact that the drainage is well cared for by the streams, there are no conspicuous ponds or lakes, although swamps are not infrequent. The only ponds observed were those along the coast, and the majority of these appeared to be shallow and produced by the barrier beaches.

The rainfall at the coast, as is to be expected, is rather excessive, the resulting humidity only aggravating the depressing influence of the heat, yet the latter seldom exceeded 95° F. in the shade. According to Engler and Drude,[2] Liberia is situated in a belt in which over two meters of rain falls per annum. Certainly along the coast it is more than that amount; but in the interior, at Gbanga, there was evidence of a lessening in the rainfall, and a sharper differentiation between the so-called dry and wet seasons. In spite of the differences in moisture supply, the flora of the country appears to be relatively uniform. So much so is this the case, that species found along the coast, were also collected in the interior. Thus it is evident that while moisture is a potent factor in limiting the belt of forest that extends roughly from north of Sierra Leone to the Cameroons and back from the coast to a maximum depth of two hundred and fifty miles, within the zone the distribution of floral types is limited by the nature of the soil.

The soil of Liberia is predominantly lateritic and is characterized, from the layman's point of view, by the fact that it is red and when well wetted during the rainy spells, becomes glutinous and slippery, whereas in the dry season it becomes very hard and almost impervious, and its heat reflecting capacity is very good. Analyses of this soil, according to Martin,[1] demonstrate the following as the more important substances:

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[1] The photographs reproduced in this chapter were taken by Dr. David H. Linder. — [Editor.]

[2] Engler, A. and O. Drude: Vegetation der Erde 9 (1): 876. *pl. 51.* 1910.

Al_2O_3	6.9–31.9%
SiO_2	31.7–87.1%
Fe_2O_3	3.4–11.8%
CaO	traces–2.5%

While the samples were taken in Sierra Leone, nevertheless they are indicative of conditions found in Liberia.

Although lateritic soil is predominant in the regions visited, there are exceptions. Along the seacoast, forming a narrow belt, the soil in the low almost level stretches consists mostly of sand that has been either deposited from the seas as is evidenced by the presence of barrier beaches or else has resulted from the extreme weathering of laterite. At all events, there is a definite flora, especially of the herbaceous types, that appears to be correlated with the coastal sand belt. Sandy soil, however, is not confined to the coast, for in the interior one frequently encounters stretches of almost pure sand deposited in valleys. It seems quite probable that such sand deposits are the result of weathering and erosion. Occasionally there are outcrops of sandstone so that this can also explain the presence of some of the sand deposits. Frequently also, the soil is gravelly but in such cases the lateritic soil of which it forms a part, is so abundant that it is difficult to discover any influence on the nature of the flora. Other factors influencing floral distribution such as drainage, and salinity will be considered later on in the text as occasion demands.

Brief mention should be given to the geographic relations of the flora of this region to that of others. Many of the species collected are found throughout the range of the rain forest belt, extending as we have said, from somewhat north of Sierra Leone to the Cameroons, and eastward to the northern part of the Belgian Congo. In spite of the extensive contacts such a belt provides, there are among the widespread species, also some of more limited range that appear to be confined to Liberia or at least to Liberia and bordering countries. There is an element in the flora derived from South America, that is illustrated by the presence of the cactus *Rhipsalis*, and *Maschalocephalus Dinklagei*, the sole member of the Rapataceae representing this South American family in Africa.

In the following account of the botanical aspects of the visit to Liberia, the writer has confined his observations only to those regions visited by him lying between the St. Paul and the Farmington rivers as indicated on the accompanying map. Only a very general account can be given since a large number of species, and even families of phanerogams, and all but a few of the fungi still remain undetermined.

MONROVIA AND VICINITY

Monrovia, the point of debarkation and the source of the first fruits of collecting, is situated on a peninsula formed by the mouth of the St. Paul River on the one side and the ocean on the other. This peninsula for the most part is

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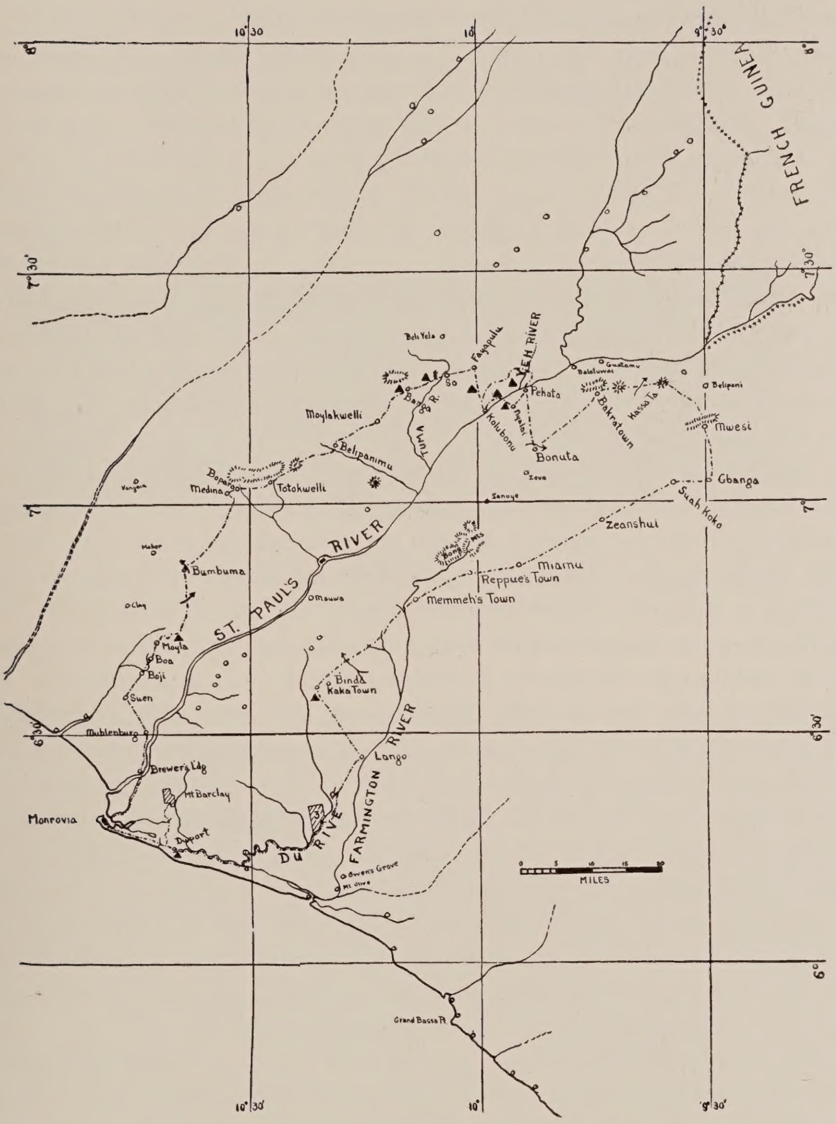
[1] Martin, F. J: Losses on igniting soil fractions. Journ. Agr. Sci. 18:123–130. 1928.


10° 30
10°
9° 30°
8°
7° 30'
7°
6° 30'
6°
FRENCH GUINEA
Beli Yela
Fayapulu
ST. JOHN RIVER
Gudamu
Balatuwai
Beliponi
So
Banga R.
Pehata
Moylakwelli
Nyalai
Kolubonu
Bakratown
Kassa Ta
Mwesi
TUMA R.
Belipanimu
Bonuta
Zova
Bopa
Medina
Totokwelli
Vangoia
Sanoye
Gbanga
Suah Koko
Zeanshui
RIVER
Bong Mts
Mahor
Bumbuma
Miamu
Reppue's Town
Memmeh's Town
ST. PAUL'S
Omauwa
Clay
Moyla
Boa
Boji
Suen
Binda
Kaka Town
Muhlenburg
Lango
Brewer's Ldg
Mt Barclay
Monrovia
Duport
DU RIVER
FARMINGTON RIVER
3
Owen's Grove
Mt Olive
0 5 10 15 20
MILES
Grand Bassa Pt.

Map No. VII. — Portion of Liberia showing regions in which botanical collections were made

Slight variation in the spelling of a number of villages occurs on this map, as follows:

Paiata = Pehata
Zeanschue = Zeanshui
Lenga = Lango

Moala = Moyla
Bomboma = Bumbuma
Kolobanu = Kolubonu

underlaid with laterite which on weathering gives rise to the typical red lateritic soil. The southern side of the peninsula, however, slopes to a sand plain which reaches to the shore and there forms the beach. Little need be said of the flora of the lateritic soil since the types that were found there, also persist well into the interior. The sand plain, however, gives an interesting example of floral succession. Immediately back from the sloping sands bordering the sea, there is a flat or slightly depressed zone in which grow one or two sedges, among them *Remirea maritima.* These plants spread by extensive underground stolons and appear to be useful as sand binders. Further up on the beach, spreading by octopus-like repent vines is *Ipomaea Pes-caprae,* the leaves of which, as is true of many plants living in such xerophytic conditions, are thick and fleshy. The flowers, pure white, are produced singly on short erect pedicels that arise from the underground stolon-like stems. According to the native boys who gather around the curious scientists, the leaves of this plant are used as a green to which is given the Vai name of "hoonov."[1]

The summit of the sloping beach is bordered by dense hedges of *Phoenix reclinata,* a palm which is out of keeping with one's conception of what a palm of the tropics should be, since it is only three to seldom more than five feet tall or barely reaching one's chin. In spite of its small size, it makes a formidable hedge which is difficult of penetration without the aid of a machete. Growing along with the palm or forming extensive patches by itself, is the fiber plant, *Sansevieria* sp., related to the species grown so frequently as a pot plant in American homes where it is known as "old maid's tongue." Here also, creeping over the sand or climbing over the low bushes is *Stenotaphrum secundatum,* a grass well adapted to this habitat by the leathery nature of its leaves. Further along the border are clusters of bushes ten to sixteen inches high of *Chrysobalanus orbicularis* which produce small red fruits that, although of rather insipid and slightly acid flavor, are highly rated by the boys who eagerly seek them out. Continuing along the beach almost to the rocks that form the picturesque headland of the peninsula and where the soil conditions are apparently altered by their presence, one comes across low trees of *Anona senegalensis,* the oval, somewhat rough, dark red fruits of which are also enjoyed by the natives.

Back of the beach, the land becomes almost level, but is still composed mostly of sand. This zone is rather densely populated with bushes, the height of which seldom exceeds ten feet. In the open spaces one sees the beautiful purplish flowers of *Vigna gracilis,* a plant strongly resembling the sweet pea. Of the bushes, one of the more conspicuous ones is *Dodonaea viscosa.* It is four to six feet tall, with inconspicuous yellow flowers. It is not the flowers that are so striking but rather the seemingly delicate leaves which are sticky from glandular secretions. Along with *Dodonaea* grows *Hibiscus surattensis.* The large showy yellow flowers, the throats of which are colored claret brown, immediately draw one's attention to the plant. Examination of the plant, and it need not be too close, immediately shows that the leaves are covered with very stiff bristles, a

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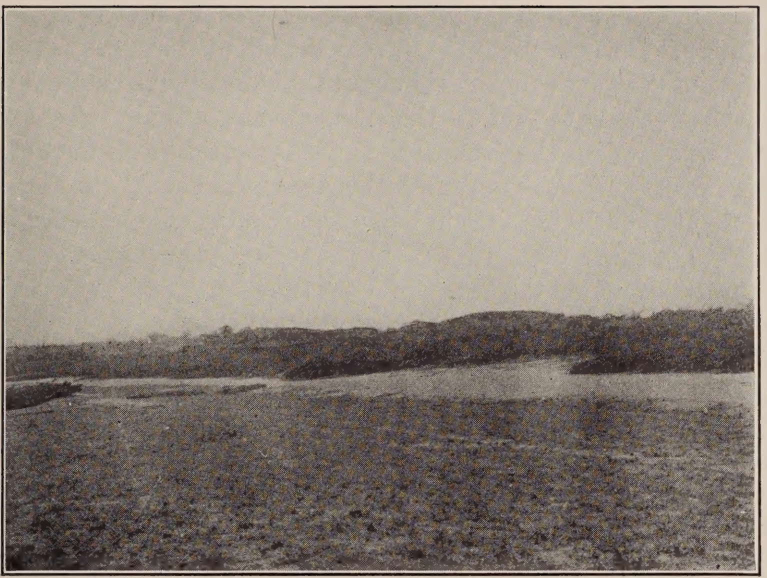
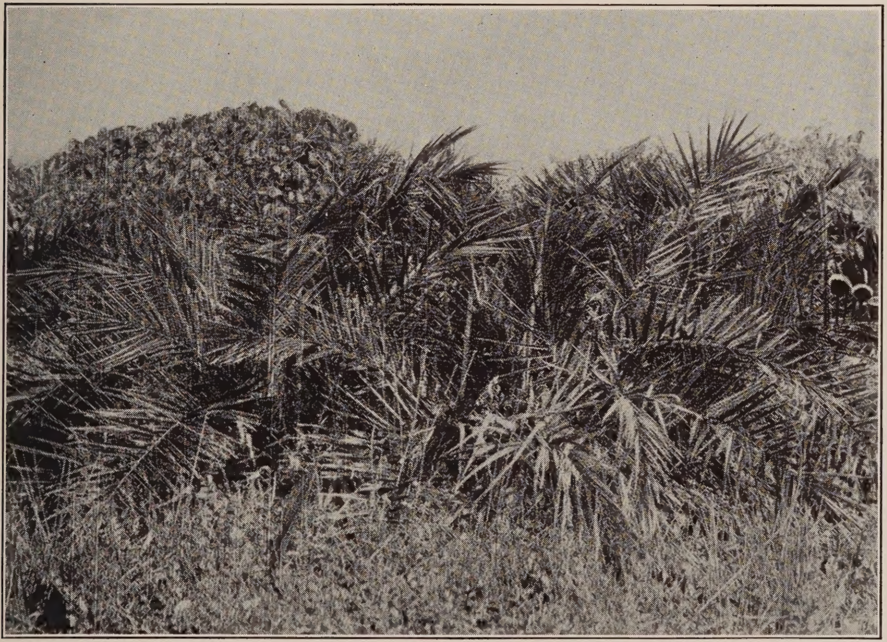
[1] All native names are spelled as they sounded to the writer, since it was impossible to obtain the same spelling from any two individuals.



No. 402. — Beach south of Monrovia. In the foreground is the flat level zone in which *Remirea maritima* grows. In the background are *Phoenix reclinata*, *Chrysobalanus orbicularis*, and *Ipomaea Pes-caprae*

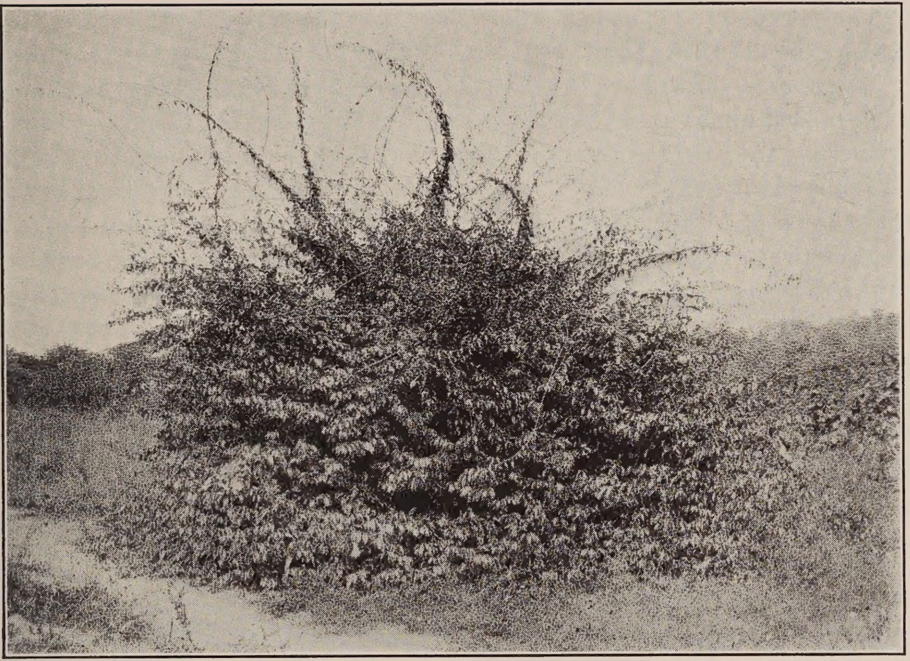


No. 403. — *Phoenix reclinata*

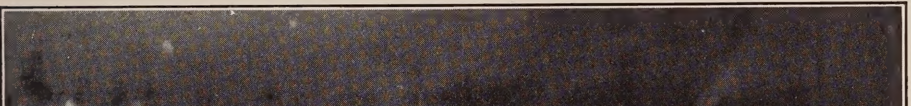
character that makes the plants useful to the natives in the treatment of "craw-craw" or itching. This use seems to have come about through the application of the principles of the doctrine of signatures, yet withal, the leaves giving an increased surface, seem to add to the pleasure and efficacy of scratching. In moist sandy depressions, the beautiful and characteristic foliage of a member of the ginger family, *Aframomum* sp., forms dense thickets. The fronds of leaves range from five to nearly ten feet in height and at the base of these on separate short pedicels, not more than a foot long, occur the white canna-like flowers in some cases, or the rounded tapering orange fruits in others. These fruits are also eaten locally. Their flavor is highly aromatic and distinctly that of raw ginger, although the texture is coarse and fibrous, a quality which reduces the value of the untreated product as a delicacy for the average white man. Some of the other bushes of this flat sandy region are *Napoleona* sp.; *Heisteria parvifolia*, the flowers of which are insignificant and pale yellow until after fertilization when the calices enlarge, become fleshy, and bright pinkish-red. This genus is of South American affinity. *Eriosema glomeratum* is also found here as elsewhere in the grassy sand plains along the coast, at least as far as Duport.

In the shallow pools occurring near the beach one finds a species of *Nymphaea*, related to *N. lotus*, and a beautiful species of *Utricularia* which produces pale pinkish-lavender flowers on pedicels that rise four inches above the surface of the water. This species belongs to the group which produces conspicuous leaves equipped with the characteristic bladder-like traps that are frequently found to be filled with lower forms of aquatic life or organic matter. Bordering the pond are low trees of *Anthostemma senegalense*, twelve to fifteen feet high, with slender pendant branches arching downward and with opposite leaves at the axils of which are produced the small greenish flowers. Nearby occur the woody vines of *Banisteria leona* of the Malpighiaceae, its bright yellow flowers arranged in conspicuous though relatively small panicles. On the same bush are also the brilliant deep red two-winged fruits.

Before leaving the sandy plain, mention should be made of three striking bushes, two of which belong in the same genus, namely *Strophanthus*. These two species, *S. sarmentosus* and *S. gratus* produce in their seeds and roots the powerful poison strophanthin which is used for poisoning arrows. The latter species which also grows in the interior, is said to produce the more powerful poison. According to information furnished by a member of the Frontier Force, these poisoned arrows were used with telling effect by natives of the village under the leadership of Suahkoko, the present village chief (who by the way, is a woman), in their stand against the encroachment of Americo-Liberian authority. The other species, *S. sarmentosus*, shown in the accompanying photograph, is a bush eight to ten feet high, the branches of which become arcuate and intertwine. On the terminal parts of the branches for a considerable distance, are produced numerous large pale pink flowers of which the petals taper to produce tentacle-like elongations. The fruit is a large two-parted affair, each wing of which is between eight and ten inches long. Wing is hardly an appropriate term, for the ovary, enclosing numerous plumed seeds, is almost round in cross-section, only



No. 404. — Bush of *Strophanthus sarmentosus*



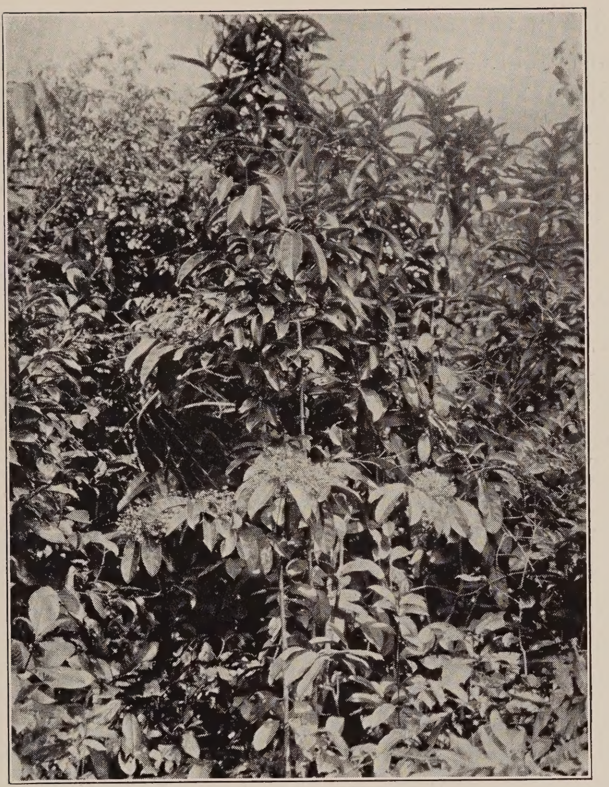
No. 405. — Flowers of *S. sarmentosus*

slightly flattened on the upper side. The other species of interest is *Cuviera acutiflora,* a bush six to eight feet tall, erect, and simple, the stem producing rather long spines. The flowers are produced abundantly in cymes that are pale green in general appearance, yet when the flowers are more closely viewed it is seen that they are pale green with a rich, though pale orange throat. The internodes of this plant are swollen and in these swellings, ants make their abode.

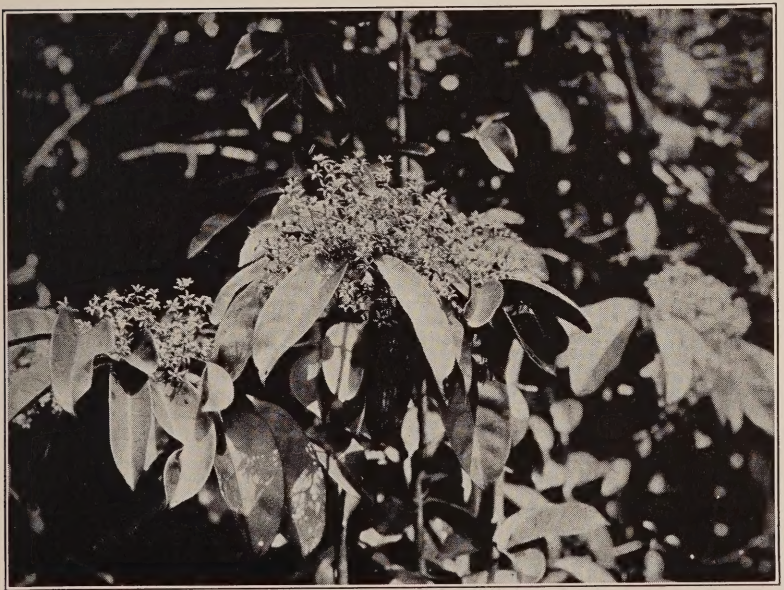
In the town of Monrovia itself, there are also a few plants of interest. Thus on the stone walls that surround the homes of the more well-to-do natives, one finds *Pilea microphylla,* a member of the Urticaceae; *Chlorophytum* sp., a genus later to be found in swamps and moist woods, and *Bryophyllum calycinum,* a "live-forever," that is small yet covered with yellowish flowers which make it conspicuous. These plants, together with an orchid resembling *Bulbophyllum,* scattered on the sides of the wall in niches and among moss, are extremely picturesque and at the same time are strong reminders of the relatively high humidity and temperature that is experienced daily. In most all parts of the town, growing in and over the hedges, is *Thunbergia alata,* known in the West Indies as black-eyed-Susan. This species was seen only in Monrovia where it is probably introduced, as was also *Alamandra cathartica,* a South American plant which is here used as an ornamental. The weeds of the town show an American origin that is quite recent, as is testified to by Herr Dinklage, the German consul who is at the same time a very keen botanist and after whom many Liberian species of flowering plants have been named. *Spigelia anthelminthica, Stenodia parviflora, Mirabilis jalapa, Cleome ciliata, Lantana camara,* and *Heliotropium indicum* are abundant in the streets and their borders. Other plants that also assume the nature of weeds are *Mimosa pudica, Micrococca mercurialis, Tachytarpheta indica, Phlomis nepetaefolia, Zornia diphylla,* and *Euphorbia stricta,* the last named with another herbaceous member of the same genus appears to thrive in the border of the streets, especially in the vicinity of the presidential mansion.

This region is not extensively exploited agriculturally. In the market only a limited variety of vegetables are offered for sale. Cassava and yams make up the bulk of the produce, although there appears to be a fair demand for the small red-hot peppers, the fruit of the introduced *Capsicum.* But a small proportion of the cassava and yams are produced in the vicinity of the capital, the greater part coming from farms upriver. Occasionally, in rambling around the outskirts of the town, one comes across small patches of cassava and yams in back yards or gardens. A few trees of *Carica papaya,* or of the bread fruit, *Artocarpus incisa,* and more abundantly the banana, supply the family needs. Some of the backyard gardens also supported a few pineapples or sugar cane. Citrus trees are for the most part, relatively scarce.

On the level sandy zone previously mentioned, occurs the only instance of agriculture on a fairly large scale. Here there is a grove of coconut palms which appears to be doing very well, as should be the case when the land is relatively low and near the sea. In spite of its thriving appearance, however, Dr. R. P. Strong, leader of the Expedition, discovered some cases of the red-



No. 406. — *Cuviera acutiflora*



No. 407. — Flowers of *Cuviera acutiflora*

ring disease (p. 389 of this Report). This find is of exceptional interest, since heretofore, the disease has been reported only from the American tropics. The writer has seen its effects in Trinidad and British Guiana, although it is also known from Tobago, Grenada, British Honduras, Panama, and Venezuela, and then only on *Cocos nucifera* and in one case on an undescribed species of *Cocos*, not on other palms. The parasite has been described by Cobb [1] as *Aphelenchus cocophilus*. Since the symptoms of the disease are the same and since only the coconut appears to be attacked, it seemed quite possible that the nematode was the same as that found in the Western Hemisphere, and that the organism might have been transplanted by its eggs on imported seeds. If, however, the species proves on more careful study to be endemic, then an interesting field of investigation is open to the plant pathologist to determine whether the organism is as specific as is indicated, and if not, what other hosts are infested.

At all events the symptoms of the disease in the two regions appear to be much the same. The trees so infested are characterized by a yellowing of the older fronds which progresses until all but the youngest ones are involved, and these eventually succumb. The trees at an advanced stage of infection become rich yellow and then a rich golden brown. The internal symptoms are quite decisive. A zone, one to two inches wide, at first dingy-yellow, then dull-red, is formed one or two inches from the periphery, and extends up the tree a distance that varies with the age of the infection. Root infection, in the case of *Tylenchus cocophilus*, according to Nowell,[2] the discoverer of the nature of the disease, is confined to the cortex between the horny hypoderm and the central wood strand.

The mode of infection is not definitely known, although Nowell [3] considers it possible that the worms ascend from the soil by way of the surface of the stems and gain entrance at the base of the leaves in the same manner that rice and black currants are known to be infected. Just as the exact mode of infection is uncertain, so too is the method of control. In view of the fact that when the trees die the soil becomes heavily infested, it is obviously a good practice to cut the trees into convenient lengths and then to burn them thoroughly, since charred parts may still harbor the parasites. Furthermore the roots should also be excavated and burned with the trunk and leaves, the incineration being performed over the excavated area formerly occupied by the trees. This is done in order to bake the soil.

A VISIT TO THE RUBBER PLANTATION AT MT. BARCLAY

While in Monrovia awaiting completion of arrangements necessary for the subsequent expedition into the interior, the writer, through the courtesy of the Firestone Plantations Company, was afforded the privilege of visiting one of their stations. The first impression one receives is the park-like appearance of the plantation. The undergrowth, because of the frequent removal is almost entirely absent, and the rubber trees (*Hevea brasiliensis*) are devoid of limbs for some distance up the length of the straight trunks. These factors, coupled with the regularity of planting, give the appearance of a well-kept forest park in which the crowns of the trees produce almost continuous shade. Here and there one sees the light V-shaped cuts on the trunks, indicating that tapping is still going on, since in most instances, at the bottom of the V's white porcelain cups are suspended and into these drops the white, thick, milky latex. In the distance, passing among the trees with buckets suspended from yokes, the natives are seen going about their work of collecting the latex. The collections are then taken to a rustic house in which the rubber is coagulated, eventually to come out in the form of a whitish lump of doughy material. This then is washed and put through a rolling mill, a process that removes the excess liquid and at the same time produces large sheets that resemble waffles. These are then dried and baled for shipment to America.

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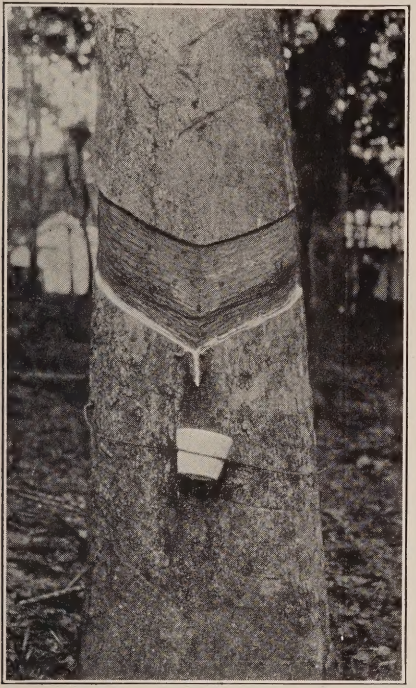
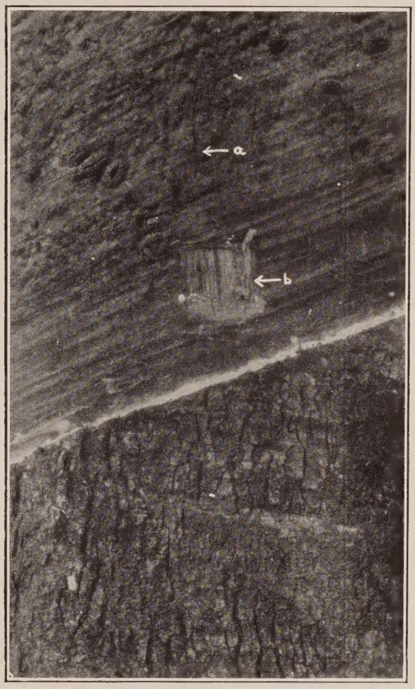
[1] Cobb: West Indian Bull., 1919, Vol. 17, p. 203.

[2] Nowell, W.: West Indian Bull. 17:189. 1919; 18:73. 1920.

[3] *Ibid.*: Diseases of crop-plants in the lesser Antilles, pp. 177–182. West India Committee, London. 1924.

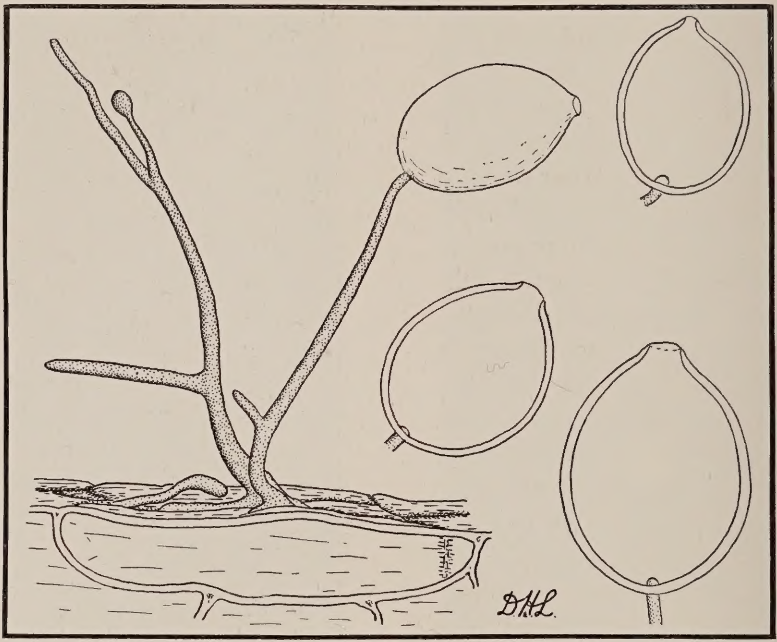


No. 408. — Method of tapping rubber trees



No. 409. — Early stage of black thread blight. Cracking of tissue shown at *a*. Outer tissue removed to show black discoloration of wood at *b*

When the period of latex production has about passed and, according to the overseer, the weather is wet, the cuts in the trees become infected with a fungus. The first symptom of the disease is the cracking in vertical lines of the cortex that remains after the outer layer is removed in tapping. Around the cracked lines there is a depressed area, underneath which the tissue is blackened. At the same time the cambium layer is killed to depth of a quarter of an inch. With age the blackening becomes evident externally, the lines elongating and tending to fuse, thus forming a darkened area with a ragged diffuse outline. In wet weather this blackened surface is covered with a white cottony layer in which the zoosporangia of *Phytophthora* are produced. These symptoms are in very close agreement with those described by Petch [1] for black-thread blight of *Hevea* in Ceylon, caused by *Phytophthora Meadii.* He also states that this fungus attacks the fruits first and from these the leaves are infected, and from the leaves the fungus is spread to the wounds made by tapping. An additional species *P. Faberi* Maubl. is recognized as causing the garnet red discoloration of *Hevea* bark. The separation of these two species has been questioned by Ashby [2] who places both forms in the "rubber group" as a strain of *P. palmivora* Butler. If such is the case, then this organism has dangerous potentialities should it by chance follow the same trend that it has followed on cacao in Trinidad. Although the writer does not wish to be an alarmist, it certainly seems decidedly worthwhile to investigate further the pathogenicity of this fungus in relation to *Hevea,* especially since a count at random showed nine out of thirty-nine trees, or twenty-three per cent, to be infected. In addition to *Phytophthora,* there also was present with that genus, a species of *Fusarium* of which both the micro- and macrospores were found. It seems quite probable, however, that this is secondary, and may even lead a saprophytic life on the small amount of latex remaining, yet in view of the parasitic nature of the genus, this too deserves attention.



No. 410. — *Phytophthora Meadii,* the cause of the black thread blight, showing the discharged sporangia and their variation in size, x 1000

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[1] Petch, T.: The diseases and pests of the rubber tree, pp. 119–133. Figs. 13–14. London, 1921.

[2] Ashby, S. F.: Trans. British Mycological Soc. 14:18–38. 1929.

Aside from the pathological point of view, the rubber plantation is extremely interesting to the mycologist because of the fungal forms growing not only on the woody detritus, but also on the ground. Thus the writer found here several species, among which there was an orange, unbranched *Clavaria*, a *Thelephora* apparently related to *T. terrestris*, and a species of *Geoglossum*. The latter genus, so far as can be determined from the literature has not been reported previously from tropical Africa, although it is represented in North America, Brazil, Europe, India, Java, Australia, and Japan.

The Coastal Region

Leaving Monrovia and travelling in an easterly direction, we pass, after about two miles, from the red lateritic soil that forms the backbone of the peninsula. Here one encounters what appear to be old plantations of the oil palm (*Elaeis guineensis*). For the most part the trees appear to be rather old and past their prime, numbers were either dead or dying. Beyond the main plantations, the palms became more scattered and the country then becomes fairly level, open and grass-covered, with here and there clusters of low trees. The grass, *Adenanthus* sp., was most in evidence because of its height. The clusters of trees appeared to be predominantly *Parinarium macrophyllum*, a member of the Rosaceae, which produces an edible fruit called variously by the natives, "peaches" or "monkey plums." Single bushes of *Lonchocarpus macrostachyus*, six to eight feet high and producing long, twisting, winding branches are occasionally distributed in the grassy openings. Among the low bushes and climbing therein is an occasional lily, *Gloriosa virescens*, adapted to its mode of living by the tapering of the ends of the leaves to produce twining tendrils. The flowers, scarlet red, while brilliant and conspicuous in a garden, are not at all so in the native habitat, where the color merges with the green of the surrounding foliage. Of the commoner roadside plants, *Sida carpinifolia* appears to be most abundant, with *Crotalaria falcata* equally prominent though much less numerous.

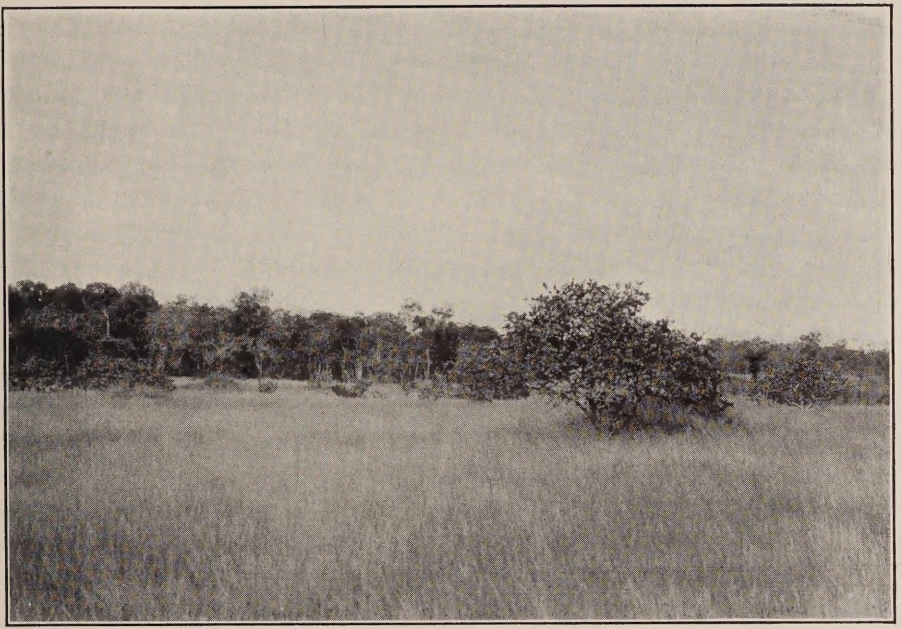
Here and there, lateritic outcrops are encountered and immediately, in contrast to those seen on the sandy plains, the trees become tall, dense, and typical of one's expectation of a tropical rain forest. From some of the trees, a considerable distance above ground, one sees the slender, pendent vines of a *Vanilla* orchid which apparently is not profuse in the production of flowers, and even less so in the production of seed pods. The flowers are not conspicuous from the distance since their color is greenish yellow except for the sepals that are veined with purple.

At the base of the hills formed by the lateritic outcrop, the sand of the savannah is kept moist by seepage and in such places sedges and grasses abound, among which are also the inconspicuous plants of the club-moss, *Lycopodium bulbiferum*. Taller and more conspicuous is *Honckenya ficifolia*, its showy magenta flowers, or its bristly red fruit-capsule standing out in welcome relief against the surrounding yellow-green of the various grasses. In the swampy depressions also formed between the hills, *Mesanthemum radicans*, a relative of the deer grass, *Eriocaulon*, produces clusters of leaves that are one to three feet long, and among and slightly exceeding these are the pedicels surmounted by white button-shaped flowering heads.

A salt water creek penetrates the lower sand belt. At high tide the creek overflows its low banks and forms a shallow lake that follows the course of the inlet some distance inland. In this locality, as might be expected in the tropics, grows the mangrove, *Rhizophora racemosa.* While the species is abundant at the mouths of the St. Paul, Du, and other rivers where saline conditions are prevalent, this locality is of especial interest since it shows the mangrove tangle in the process of formation, — from low isolated bushes to trees fifteen or twenty feet in height. But it is even more interesting to find growing on the flats that are periodically submerged by brackish water, plants which generally belong in habitats where only fresh water is available. Here two species of *Xyris,* one with purplish the other with yellow flowers, and a species of *Eriocaulon,* thrive in varying degrees of abundance. In a pool, shallow at low tide a species of *Nymphaea,* presumably *N. lotus* also persists. Twining among the low grasses and sedge, is a plant that produces clusters of beautiful sky-blue flowers that resemble those of a *Lobelia.* When the plants were carefully dug up and separated from the grass and mud, they proved to produce pockets on the under side of the simple leaves, thus quickly placing the species in the genus *Utricularia.* So far as the writer is aware, such a species has not been reported from Liberia. At the edge of the flats, several spiny bushes of *Ormocarpum verrucosum* make themselves evident, not because of the flowers which are white and inconspicuous, but because the bushes, ten to fifteen feet tall, are made difficult of access by the long twisting and ascending branches.

Because of the unexpected forms encountered, such a region has its fascination and it is with regret that, because of the paucity of time, it must be left for future exploration. The land again becomes higher, and almost flat, and the soil becomes drier and more sandy. Except for a few gardens of cassava, and a scattering of palms and other trees, an open landscape is afforded in which the silky plumes of the grass *Imperata cylindrica,* wave in the breezes. An occasional termite hill stands out against the background of palms or forest trees. Again *Anthostemma senegalense,* previously seen in the neighborhood of Monrovia, grows in isolation. This time, however, the trees although on dry sandy soil, reach a height of about thirty-five feet. After going by patches of bracken fern, *Pteridium aquilinum,* a few clusters of low bushes, and scattered trees of the "monkey plum," Duport is reached.

Duport, a village consisting of a house, a storage shed, and five or six mango trees, while not in itself interesting, proved to be situated in an interesting locality. The sand plain on which it is established, slopes in all directions but one, toward a densely-forested swamp, so that all degrees from dry to wet sandy soil are present. In the moist pockets of the upper drier level is the tall yellow-flowered species of *Xyris, X. indica,* apparently confined to this special habitat. In the lower wetter parts of the plain is another species of *Xyris* with purple flowers, that may, on identification prove to be the same as one



No. 411. — Open grassland in the coastal belt near Duport. The low tree in the foreground is *Parinarium macrophyllum*

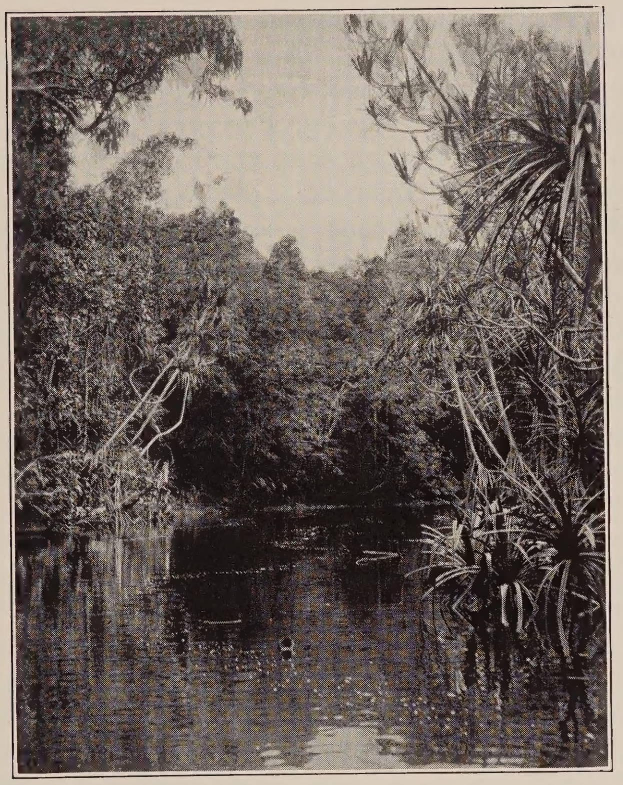
No. 412 — Bracken fern near Duport

of those previous noted on the brackish flats. Along with the *Xyris* grows a species of the yellow-eye grass, *Hypoxis*, also *Lycopodium carolinianum*(?), a violet-flowered *Lobelia*, and a species of *Eriocaulon* that differs by its hairy stems from that previously collected on the brackish sand flats. Then, too, there is *Habenaria confusa*, resembling our less showy American species; two quite distinct species of *Utricularia*, both with inconspicuous simple leaves that are partly buried in the sand, but one of them producing white flowers, the other yellow ones; and finally there is a white-flowered species of *Drosera*. To one who has collected representatives of these genera in New England, there is a striking similarity in the habitat. It is all the more striking when one considers that except for differences in temperature, the conditions are the same in the tropics of the Eastern Hemisphere as they are in the temperate regions of the Western.

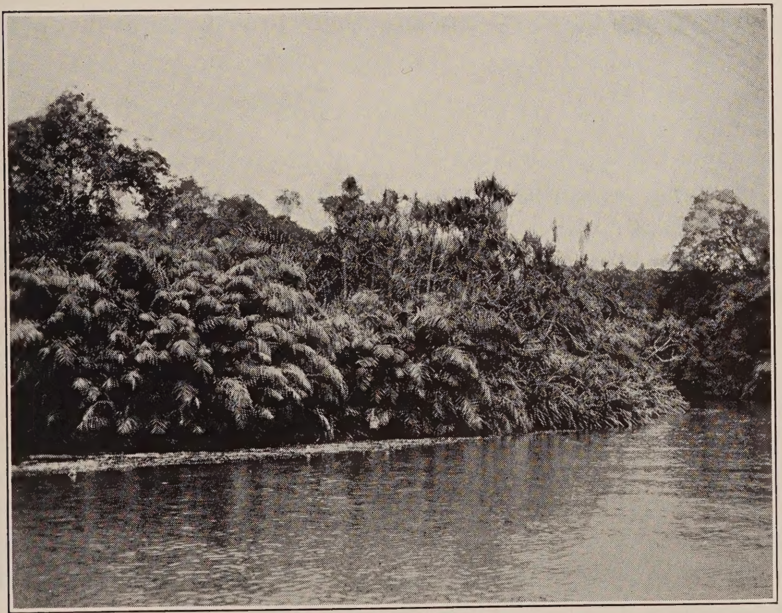
The sand plain, aside from the herbaceous types already mentioned, is not altogether possessed by grasses and sedges. There are occasional small bushes, and low trees that do not exceed thirty feet. The latter, however, seem to prefer the lower soil at the forest edge. Thus one finds *Dolichos Dinklagei*, *Smeathmannia laevigata*, two rubiaceous plants resembling *Coffea*, *Chrysobalanus ellipticus*, and *Memecylon spathandra.* An additional herb should also be mentioned as it too grows in the wetter habitats, and this is *Sauvagesia erecta*, a plant widespread in similar environments throughout the parts of Liberia that have been visited.

Up the Du River

The swampy forest bordering the sand plain is for the most part difficult of access, made so by its flooded nature, as a result of which it is necessary to progress from base of tree to fallen moss-covered log, and failing these, to wade knee deep in water. The forest may best be seen from the motor boat as it makes its way along the narrow and winding brook that eventually broadens out until it meets the Du River. From this point of vantage, on the boat, the low and swampy nature of the region is equally evident, the high spots are produced by the enlarged bases of some trees, fallen logs, or by the knee-like pneumatodes produced by a species of *Sideroxylon*, a tree some forty feet high. Overhead the crowns of the trees make a vaulted canopy, that permits only mellowed and diffuse light to reach the undergrowth. The trunks of the trees are covered with moss with here and there an epiphytic fern or an inconspicuous orchid. Occasionally a member of the Ochnaceae, with large panicles of yellow flowers, brightens up the scenery. Soon the brook widens and a breach is made above, so that direct light from the sky penetrates through the space thus produced and then along the edge of the brook, *Cyrtosperma senegalensis*, tall aroids with spiny stems flourish, as do also some tall herbaceous members of the Rubiaceae. In the brook, sending up their long, dark green, strap-shaped leaves that float on the surface are the spider lilies, *Crinum natans*, and dotted among them the beautiful white flowers with their thin strap-shaped corollas. As we continue downstream, an occasional rattan



No. 413. — *Pandanus* or screw pines along the Junk River



No. 414. — *Raphia* palms along Du River

palm is seen climbing over the trees, and then comes a definite zone of the screw pine, *Pandanus candelabrum.* The dense tropical jungle recently left behind gave the impression of a restored forest of the carboniferous period. This impression is emphasized by the Pandanus jungle. The cumbersome arched, ascending stems with their long sword-shaped leaves, and the vast numbers of descending aërial roots make a picturesque scene, although to those who use the stream as a waterway, they constitute a distinct and unmitigated nuisance that must be removed at all too frequent intervals. This zone persists almost to the junction of the Du River, where the brackish influence is felt and then the mangroves succeed them and remain the dominant plant for a considerable distance up that river, affording a rather monotonous scene that is only occasionally punctuated by the pinkish flowers of a *Hibiscus* that manages to compete with its associate. As the land becomes higher a mixed forest appears and a number of gigantic, gray, columnar boles, buttressed at the base and surmounted by a widespread crown, stand out above the surrounding forest. This is the silk-cotton tree, *Ceiba pentandra,* one of the most stately of the forest trees. Later on *Raphia vinifera* grows in almost pure stands along the river. Especially good stands are noticeably present on the inside of the curves of the river where the gravelly eroded soil had been deposited, a fact seemingly correlated with the ability of the seeds to find a place in which to germinate. As the land becomes higher and the current of the river becomes swifter, the Raphia palms disappear and taller trees take their place once more, and over these climb numerous vines, among which *Ecastophyllum Brownei,* a leguminous species with great numbers of white flowers, is prominent. More rarely a species of *Combretum* makes a showing with its reddish flowers. The taller and most numerous trees belong to the Leguminoseae, many of them sending their branches out horizontally over the river.

Firestone Plantation No. 3

After a day's trip up the river so full of interest and variety, the clearings made for planting rubber seedlings are disappointing at first sight from a botanical standpoint; yet when once camp is established and equipment is prepared for taking care of specimens, such a feeling soon vanishes, since because of the very fact that the felling of trees is still going on, there is an excellent opportunity to collect specimens that are otherwise unavailable without a great outlay of time and energy. Also, a fine opportunity is afforded for collecting inaccessible epiphytes.

The region in which the plantation is located is fifteen or twenty miles from the coast as the crow flies, and is somewhat above sea level. Furthermore, the terrain is hilly and rolling, some of the well-forested hills rising two or three hundred feet above the level of the river. Thus there is afforded a chance to collect in three different types of localities: river edge and adjacent low ground, swamp, and the higher elevations of the hills.

Extending back from the bank that is four to six feet above the river, the land is for the most part sandy and level. Here the tall trees *Dialium Dinklagei* and *D. guineense* reach a height of one hundred and seventy-five feet, and *Brachystegia leonensis, Macrolobium macrophyllum,* and *Pterocarpus santalinoides* approximately one hundred and twenty-five feet. Of the lower trees of the same family, Leguminoseae, *Loesenera Kalantha,* its large, subrectangular, brown pod, standing horizontally, like the arms of a signal tower, and a species of *Copaifera* form the secondary rank, attaining a height of fifteen to thirty feet. The lower trees are accompanied by such species as *Phyllanthus discoideus, Macaranga huraefolia, Microdesmus puberula, Pycnanthus kombo,* and many others. The silk cotton trees also are present here, as elsewhere throughout the region visited, their trunks, because of the softness of the wood and the regularity of the grain, being used in the manufacture of dug-out canoes.

Growing epiphytically, are numerous mosses and several epiphytic ferns and orchids such as *Polypodium Phymatodes* and a form of *Asplenium normale* of the second group, and the conspicuous *Angraecum Eichlerianum* of the last. This species, while not rare, is by no means common. It is characterized by its opposite leaves on a pendant stem that tends to arch out from the supporting tree. Among the terminal leaves are produced the modest yet beautiful flowers with their yellow-green sepals and their white petals and lips. Less conspicuous because of their small size and the fact that they grow on the upper almost horizontal limbs of the taller trees, are the small spikes of inconspicuous apricot-colored flowers of *Listrostachys bidens.* Even less obvious are the small fern-like plants of *Mystacidium distichum* which, according to Schlechter,[1] belong in a genus known only from the eastern extratropical regions of South Africa. The only *Begonia* collected by the writer, *B. rubromarginata* was found here.

Bordering the brooks that empty into the Du River, an occasional bush of *Ouratea flava* and *Smeathmannia pubescens* is seen in flower, — the flowers of the former in large yellow panicles, of the latter, white, about an inch in diameter, and produced singly. In the opening of the tall forest, by the riverside, *Mikania scandens,* of apparently wide tropical distribution, climbs over the taller bushes and low trees in great profusion. A species of bamboo, not in very great numbers, appears to do well in the wet and less densely-forested region not far from the foot of the hills, while the five-foot tall orchid, *Lissochilus Horsfellii,* seems to do better in the more open and grassy places. Along the path in the more gravelly and slightly more elevated places in the tall forest occur many herbaceous types of the families Rubiaceae and Acanthaceae. Here, too, *Lycopodium cernuum* and one or two species of *Selaginella,* to say nothing of terrestrial and climbing aroids, find favorable conditions.

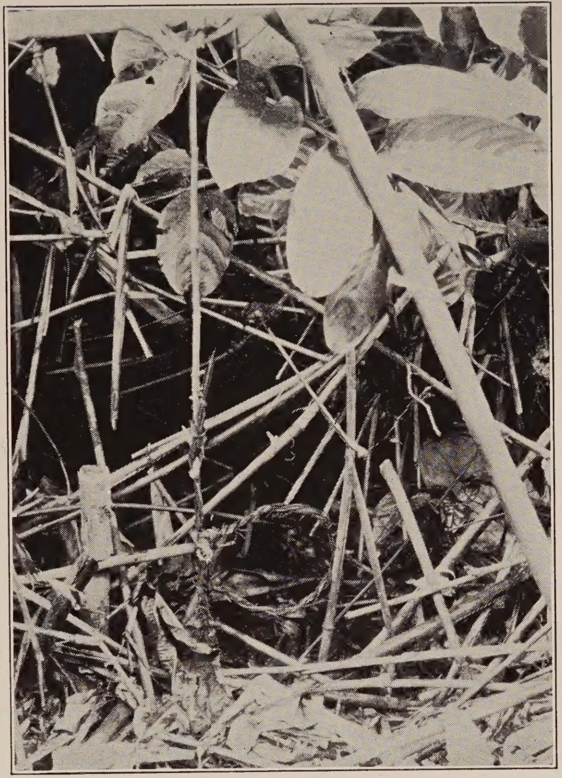
An occasional apocynaceous tree twenty-five feet high, or the climbing rattan palm, *Calamus Barteri* claims the swamp, as contrasted with the low ground, for its habitat, but such species are greatly outnumbered by *Raphia vinifera,* the raphia or wine palm. As has already been noted, this species occurs in the lower reaches of the river. Here, where the river is swifter, and

[1] Schlechter, R.: Die Orchideen. 2nd ed. p. 588. 1927.

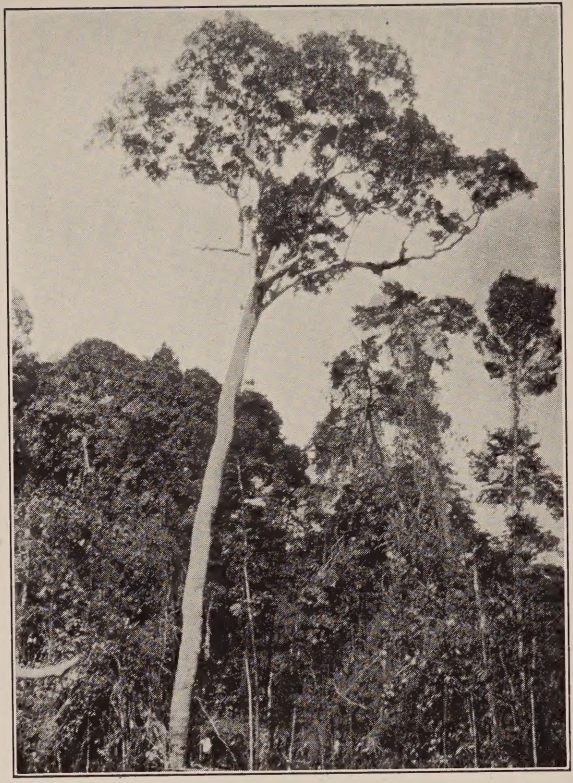
the banks more precipitous, the palms have taken to the swamps and become dominant. To the natives these trees must be considered a heaven-sent blessing, for not only do the fronds furnish fences, and thatching for their huts, but perhaps as celebrated and equally important, it furnishes a sort of wine. When first fermented, before reaching the vinegary stage, the beverage is slightly sweet and lightly flavored with an aromatic essence that is not altogether disagreeable. While the alcohol content is about the same as beer, it nevertheless is slightly exhilarating if enough is absorbed. Undoubtedly the liquor as used by the natives must be more concentrated, for when it is imbibed by porters on the march, they soon begin to chatter and sing with zeal. By the time the wine has received sufficient strength to produce that effect, however, it has lost its agreeable taste, and seems to be teeming with life. A word should also be given to the use of the fronds in making fences for capturing wild game. These are chin high or slightly lower, and extend for some distance, occasionally they are as much as three hundred yards long. Openings, a foot in diameter are made near the ground at frequent intervals and in each of these is placed a noose so arranged that when the trigger is touched, a sapling bent to form a bow is released, and the noose is tightened. This form of snare, shown in the accompanying photograph is used for ground birds and small animals.

No. 415. — View to the south from Firestone Plantation No. 3, to show the slightly rolling country and occasional hills

The floors of these raphia swamps are frequently carpeted by species of *Selaginella,* with Marantaceous plants occasionally forming the undergrowth. The only other plant in this place is a vine that grows over the palms and produces clusters of large pea-shaped flowers on the end of pendant stems. The flowers are described in the field notes as being at first white, then with age and just prior to dropping, becoming "light drab," the inner upper petals



No. 416. — Snare used to catch small animals



No. 417. — *Xylopia africana.* The immense size of the tree may be judged by comparing it with the native at the base

"cinnamon drab" (Ridgway, R. — Color standards and color nomenclature. Washington, D.C., 1912). This is apparently a species of *Mucuna.* In the forest at the edge of the swamp, and in sandy soil is a conspicuous species of *Aframomum,* the leafy fronds of which are ten to fifteen feet high. The flowers, produced at the foot of the cluster of fronds near the ground on separate pedicels, are pinkish with yellow throats. The fruits of this species, as of the one noted in Monrovia, are also eaten by the natives, and have the same flavor and texture. An interesting fungus was found in this swamp, one that heretofore has been reported only from South America and the West Indies. Just as in those places, this species, *Delortia palmicola* of the Fungi Imperfecti, forms small, white, gelatinous, hemispherical, fruiting bodies on the old decaying parts of the fallen palm fronds or on old stumps.

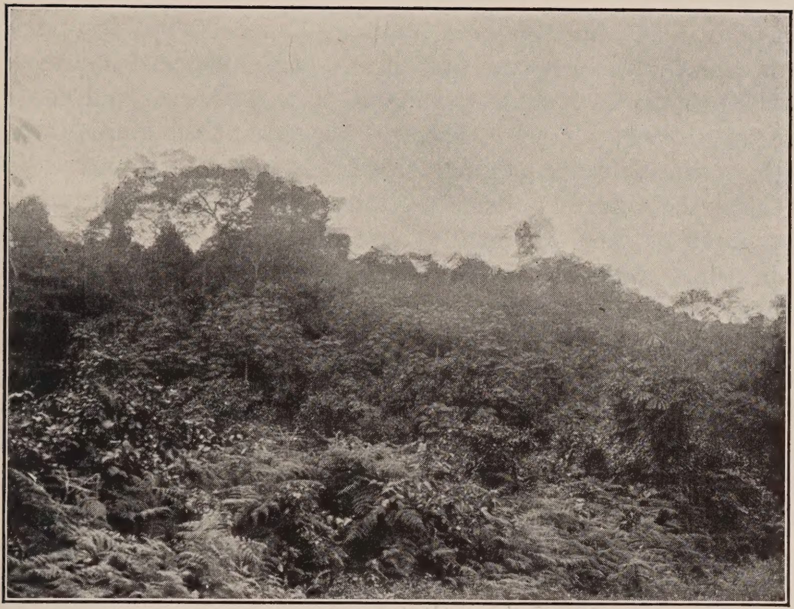
Crinum natans grows here, not in the river, but in little pools in the open made by the enlargement of the small brooks that drain the swamps. It, *Crinum,* is accompanied by the white tropical water lily of the genus *Nymphaea.* Along the shallow margin of the pool, and indeed where there is any seepage and the ground is wet, the water fern, *Ceratopteris thalictroides* abounds.

At the higher level, on the hillsides, the flora is somewhat different from that of the lower levels, although *Dialium guineense* persists almost to the summit of the hills, where the tree, one hundred and seventy-five to almost two hundred feet high is in flower, although the flowers, light creamy white in color, are barely visible from below. The trunk of the tree at shoulder level is a foot and a half to two feet in diameter, and when cut, exudes from the cambium layer a red gummy substance. A more abundant tree is *Xylopia africana* that attains a height of about one hundred and fifty feet and appears to have an almost continuous fruiting season. When first collected on July 25th only fruits were seen on the trees and at that time they were green, yet two weeks later, while the mature bluish-green fruits still persisted, the tree was in full flower. It is quite possible, probable in fact, that such a deduction is erroneous and that the production of fruit takes place either only during certain parts of the year or in alternate years. On the ridges of the hill grow single specimens of *Cola chlamydantha,* a tree only twenty-five to thirty feet high, which produces its flowers caulicolously. These flowers, thick and fleshy of corolla, are grayish externally, but scarlet red on the inner surface. Above, at the apex of the long slender trunk, the branches arise sparsely in an irregular whorl and at or near the ends of these are produced the large palmate leaves on foot-long pedicels, in the cavities of which, two species of ants are harbored in compartments separated by septa. Another tree, apparently rare in the virgin forest, is *Musanga Smithi,* the umbrella or cork tree which has a crown of large palmate leaves. The wood of this tree is very light, and when cut, gives off the odor of sumac. A species of *Clerodendron* is one of the more striking lianes in this forest, striking, not for the fact that its thick stem extends to the top of the lower trees, but because of the fact that its panicles of white flowers are produced on the lower parts of the stem, some of them actually touching the ground. A more slender liane, is *Salacia pyriformis,* of the upper hillside forest and it also grows over the lower trees. A number of bushes, mostly belonging in the Rubiaceae are also present, but since these have not been classified no mention can be made of them. Of the herbaceous plants, perhaps the most striking one is a species of the sedges belonging to the genus *Mapania.* It is not here an abundant species, and the few plants are well scattered. The leaves of this sedge, about two and a half feet long, and a little over an inch wide, come together to form a base that is triangular in cross-section. From the center of this, the stalk rises above the leaves and is terminated by a dense, brownish, globose head, a good inch and a half in diameter, over which are scattered the elongate white anthers. In the shade of the higher trees, but growing on rocks in the little ravines, *Marattia fraxinea* manages to withstand the vicissitudes of its existence, apparently able to hold its place in spite of the small torrent that rushes over it during the heavy rains. Bordering this same ravine, and growing on the gravelly bank, *Dryopteris pratensis* sends up its triangular frond from creeping rootstocks. A related species, *D. mollis,* grows in the lower ground in the woods. Rotted wood supports a number of fungi, the greater part of which are resupinate or substipitate polypores. The prettiest and most delicate member of this group, apparently scarce, is the few-pored, fleshy, orange *Laschia.* Several pyrenomycetous fungi also thrive, and among these two or three species of *Xylaria,* and close to these in taxonomic position, the dichotomously branched *Thamnomyces Chamissonis.* The agarics appear to be poorly represented in the deeper forests, although two or three species of *Marasmius* were collected.

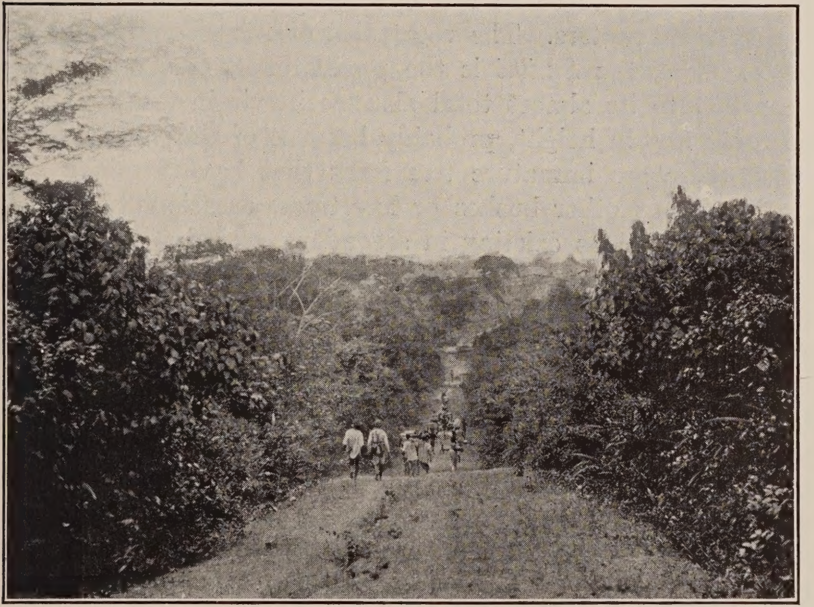
Before leaving Firestone Plantation No. 3, mention should be made of the flora of the cleared, but uncultivated areas. The removal of shade here appears to favor the growth of some species, as a result, three or four species in the Commelinaceae are very abundant as are also three members of the Convolvulaceae. One of the common plants of such places is *Momordica Charantia* which is characterized by having yellow flowers that are three-quarters of an inch in diameter. The tapering, warty, orange fruits are abundantly produced, but the most characteristic feature is the pungent, almost stifling odor produced when the plant is bruised. Another member of the Cucurbitaceae, a climber with deeply three-lobed leaves, and without the pungent odor is *Coccinia cordifolia. Dissotis multiflora* and *Dinophora spenneroides,* of which a few plants were seen in the shade on low ground, are apparently favored by the change in their habitat, for in the clearings they are more numerous. Just as certain of the flowering plants are favored by the change, so too are the fungi, because of the amount of decaying wood. The red pore-fungus, *Polyporus sanguineus,* seldom seen in the forests, is here quite prominent though not excessively abundant. It is a species that is widespread through the tropics. Other species of the same genus also become more evident, as do two or three species or forms of *Favolus.* The widespread *Cyathus striatus* (?) is rather scarce while members of the genus *Xylaria* are fairly well represented. A *Daldinia,* seemingly *D. concentrica,* another fungus of almost world-wide distribution is surprisingly abundant, especially so on those logs which have been slightly charred by fire. One of the most striking finds during the brief stay in this region, is that of *Strobilomyces strobilaceus* or what apparently is that species. It agrees in macroscopic detail with the species as found in North America, excepting that the scales on the pileus appear to be slightly more appressed. Unfortunately the microscopic characters have not as yet been studied, but even should these prove of specific difference, this is the first collection of *Strobilomyces* from tropical Africa unless it has been reported in very recent years. The genus heretofore, while widespread in temperate Europe and North America, is only known outside of these regions from Australia. Subsequently in this same region, representatives of the Agaricaceous genera *Lepiota, Amanitopsis,* and *Pleurotus* were found. The collection of these forms is a strikingly different experience from that enjoyed by the writer during eight months in British Guiana, South America, for there, although the genus *Marasmius* was copiously represented, but relatively few of the other genera were seen and none of the Boletaceae of which, aside from *Strobilomyces,* one species was collected at Miamu in Liberia and one or two in the Belgian Congo.

Firestone Plantation No. 3 to Gbanga

As the crow flies, Gbanga is in a general northeasterly direction from Plantation No. 3. The first few miles of the journey are mostly through low country with a dense forest covering in which a species of *Burmannia* appears to be rather abundant, growing in the deposits of leaf mold. Only a few specimens of this were collected in the region just left behind, and there they grew near the top of a hill in the leaf mold collected between the roots of a buttressed tree. At first sight this appears to be inconsistent, — in one locality growing near the hill-top, in the other, growing in the low deep forest. Yet when the two habitats are compared, both are found to be relatively moist, and both have an abundance of leaf mold. The latter factor, however, appears to be the more decisive. Near the village of Nickabo Half Town, in moist sandy soil, somewhat exposed because of the thinness of the secondary forest, the adder's tongue fern, *Ophioglossum* sp. grows in relative abundance. Beyond Nickabo Half Town, a small village in which bananas, yams, and cassava appear to be the main agricultural staples, the land again becomes higher, rolling, and well forested. This area is drained by small brooks, some of them very picturesque as they fall over the rocks in the deep shade of the forest, or pass through little glens. On the bank of one such brook a *Secotium,* apparently a new species, was collected. The brooks become fewer, but the country remains rolling and well forested almost to Lenga Town. The sedge, *Mapania,* rare around Firestone No. 3, becomes more abundant. Again the little polypore, *Laschia* is seen on fallen logs, although apparently another species. In this forested area a number of other fungi are seen, yet because of the constant travelling it is impossible to collect and care for them. A beautiful little *Lepiota* with bright orange stipe, pileus, and annulus was collected. A purple *Clavaria* strongly resembling *C. amethystina* proved to be too fragile to stand the constant jarring, and arrived in camp so damaged that it was impossible to make



No. 418. — Second growth near Kaka Town. In the foreground are young tree ferns and behind them are trees of *Musanga Smithi* with large palmate leaves



No. 419. — Second growth formation near Gbanga. The bush on the right hand side of the path is *Alchornea cordifolia*

a specimen of it. The first night is spent at Lango Town, around which are rice fields of considerable size, the first of any consequence to be seen.

The next morning we resume the march in a rainstorm and continue in it most of the way to Kaka Town. The trip, because of the abundance of secondary growth or the presence of huge rice fields is rather uninteresting. It is surprising to see the number of acres given over to the culture of upland rice, — many acres, forty or fifty, are seen at one time. There is very little original forest left it seems, since most of it has been cut over to make way for these fields. There is also a goodly proportion of second growth that has resulted from the abandonment of rice fields. In such secondary growth, the low tree *Haronga madagascariensis* is very abundant, and of the tall herbaceous types, *Phrynium confertum*, some ten feet tall, forms dense thickets. Open wet grassy swales are not infrequent and here numerous sedges are found, together with an occasional specimen of the tall terrestrial orchid, *Lissochilus Horsfellii* already noted near the Du River. The green, red alga, *Batrachospermum* is common and rather prolific in the numerous brooks, bordering which are numerous plants of *Cyrtosperma senegalensis*. This species is so universal in open country along the brooksides that further reference to it is unnecessary. Among the Raphia palms in the swamps, and growing in almost clean, white sand, an additional species of *Mesanthemum* is seen. It is much smaller than the one collected near Monrovia and the leaves have a different texture. *Maschalocephalus Dinklagei* was found in a somewhat similar habitat by Dr. Bequaert.

The country continues to be rolling after Kaka Town, where a day was spent while awaiting porters. The vegetation also is secondary for a considerable distance. *Musanga Smithi* is the predominant tree under these conditions, in contrast to its almost total absence in virgin forest. The trees do not exceed forty feet in height, probably because of the youth of the stands. Locally, also, there are immature tree ferns that have attained a height of four feet. Numerous other bushes or low trees, occasionally vines, are also favored by the conditions existing in secondary growth. Thus a low, semiligneous species of *Dracaena*, *Manniophyton africanum*, and *Combretum grandiflorum* are occasionally encountered. The original forests appear to be restricted to the swampy areas and are composed for the most part of leguminous trees. Just before Memmeh's Town we encounter two tributaries of the Farmington River, one of which we cross by means of a suspension bridge constructed from the stems of the climbing rattan palm.

Because of the lack of porters, two days of relative rest were spent at Memmeh's Town. The plants, in the presses during two days of rainy travel, were placed between relatively dry blotters and then kept before the fire in order to give them an opportunity to dry out as much as possible before the trip continued. In the intervals between the rains, sorties were made in the nearby patches of forest where additional specimens of *Mapania* and several bushes were collected. The species of *Aframomum* collected at the Du River base still persisted, and in the identical type of habitat, — low, wet sandy ground at the edges of swamps. In the upper woods a species of the Agaric, *Russula*, was also seen and an attempt made to add it to the collection, but because of the wet weather, drying was slow and the characters, once pronounced, were soon obliterated by the mass of larvae that commonly infest such fleshy forms. Around the village, a very useful weed thrives, — useful, because under the guidance of Dr. Bequaert, it was converted into a very palatable soup and furnished the first and most welcome greens.

From Memmeh's Town to Reppue's Town, is a march of three and one-half hours, during which time we plod along in an almost perpetual downpour of rain. It seems to be a question, of not how soon it will abate, but how much harder can it rain. As a result, very little collecting is done. However, *Ormocarpum megaphyllum* a shrub three to four feet high with pale dirty-yellow flowers, the petals of which are veined with purple, is collected beside a spring in a stretch of original forest, while in wet sandy depressions, among open woods, the orchid *Liparis rufina* is fairly abundant. According to the chief of Reppue's Town, a tea is made from the roots of this plant, and also from *Combretum grandiflorum*, to cure "running of the belly" that results from the chilling of that important organ. The boys, as contrasted with the porters, frequently stooped as they passed along and picked the berries of a Melastomaceous plant. These are about one-half an inch in diameter, pinkish of color, and pulpy of content. The taste is very agreeable. It is slightly sweet and somewhat acid, a property that makes them a very convenient means of quenching thirst after chlorinated water is all consumed. Subsequently this species proved to be *Tristemma incompletum*. In this same region, *Honckenya ficifolia*, previously observed in the coastal region to grow in wet meadows, grows on the dried exposed areas of low hillsides.

If the amount of secondary forest is a fair criterion, Reppue's Town is in the heart of a rice-producing area, indeed there is still an extensive acreage under cultivation. *Macaranga huraefolia* is a very abundant low tree of the secondary growth, and one which produces a yellowish translucent gum at the cut surfaces. Along the paths, and rooting at the nodes of the geniculate stems, *Isachne Buettneri* is a rather common grass, while *Panicum lineatum* less frequent, climbs to a height of twelve feet over the bushes and low trees. In a clearing of the secondary woods, an attempt has been made to produce coffee, and this, while not in great number, appears to be successful enough to supply local needs.

The distance from Reppue's Town to Miamu is relatively short, though with one or two very steep hills. One hill is of especial interest because of the fact that the southern slope is covered with whitish sand; the opposite slope, somewhat steeper, is covered with the rusty red lateritic soil. The difference in the soil of the two sides of the hills seems to depend on the rapidity and degree of erosion. Correlated with this difference in soil, there is also, especially near the summit of the hill, a change in flora.

Around the town of Miamu, the country continues to be rather deeply rolling and well forested. Here *Oligostemon pictus*, a member of the Leguminoseae, with small, white, narrow, strap-shaped petals, is encountered, as are also two species of *Mussaenda* that appear to be quite distinct from any heretofore collected. It is difficult to decide whether to classify these plants as bushes or vines. When the plants are young and four or five feet high, they most certainly resemble bushes, yet in another locality, they are vines that climb fifteen to twenty feet over the low trees and bushes, but at the same time the flowers and characteristic sepals are the same. One of the interesting finds in the Raphia swamp is a species of *Utricularia* that resembles the small yellow-flowered one previously seen in the coastal belt. Its leaves are simple, linear, and mostly buried in the moist sand in which it grows. Here, instead of being out in the open exposed to the sunlight, it persists in the rather deep shade of the Raphia palms. In the decaying detritus at the base of one of the palm trees, *Dictyophora Mölleri*, a phalloid fungus, produces its white stalk, from just below the apex of which is suspended its white, lacy veil that resembles a ballet dancer's dress. Additional genera of the Agaricaceae, such as *Entoloma*, and *Cantharellus*, and *Boletus* of the Boletaceae occur in the upper woods.

From Miamu until a short distance beyond Rua Bella, the path goes through heavy forests and up and down rather steep hills covered with the red lateritic soil. Approximately east-northeast from Rua Bella there are sugar-loaf hills, picturesque and inviting exploration, but from which our path constantly leads us. Beyond Rua Bella the terrain becomes more level and few hills of importance are encountered until the town of Zeanschue, which is situated on more or less of a plateau.

At Zeanschue the night is spent, and here we are able to purchase for supper, bananas, sweet potatoes, and a squash, to say nothing of ten eggs of which four proved to be bad. The vegetables were all produced locally, though apparently not in great abundance, the main efforts being devoted to the raising of rice. From this town to Saquella the forest is almost all primary. Beyond the latter town, the country is covered with secondary growth that soon becomes monotonous. One of the outstanding trees, however, is the thirty-foot tree of *Oncoba brevipes*. Its foliage is a deep green, the leaves large, and against such a background, the numerous large white flowers stand out in striking contrast. The land after Bundoi where another sugar-loaf hill stands out against the horizon again becomes relatively level and the secondary growth continues much the same, although the reddish flowers of the vine *Combretum grandiflorum* appear to be more numerous. Occasionally there is a vine of *Momordica cissoides* and of *Melothria capillacea*, both members of the Cucurbitaceae. This latter species differs strongly from any previously seen or collected, because of the triangular outline of its leaves. *Macaranga huraefolia* and *Phyllanthus floribundus* are both abundant shrubs. The latter species is used by the Vai tribe as an eye medicine. The purpose, according to the explanation of the writer's Vai boy, is clearly designated by the yellow spot at the base of the small white corolla. In other words, this is definitely a case of the application of the doctrine of signatures.

Around Suahkoko, a town that is situated on a flat sandy elevation, there is little primary forest except for short stretches that are confined to the swamps. The remaining area is either low secondary growth or else is given over to the cultivation of rice. In some of the rice fields, especially the more recent ones, there are a few oil palms of which the natives eat the fruits after they have been cracked between two stones. The secondary forest differs little from that already seen, although a bushy member of the Connaraceae is in full bloom. In the rather dry sandy soil at the edge of thickets, there is a very interesting little melastomaceous plant, *Dissotis rotundifolia.* The plant is prostrate and roots at the nodes from which are produced roots that in the earlier stages of development are surrounded by thick, hyaline, mucilaginous sheaths. This sheath is about as thick as half the diameter of the rootlet and apparently provides a hygroscopic layer that protects the enclosed structure from conditions of drought that are so easily brought about in such a habitat.

GBANGA

The forest conditions around Suahkoko persist the entire distance to Gbanga, a military post and the seat of government of this region. The fields of rice appear to be commensurate with the importance of the town since hundreds of acres of land are given over to that crop. Apparently an equally great area has been relinquished from cultivation and is now covered with secondary growth.

Around Gbanga the country is rolling, the low hills rounded or slightly flattened, and as just stated covered either with rice fields or low secondary bush. The Yaw River, that forms the southern boundary of the town is fed by many minor tributaries that drain the swampy areas between the hills. Outside of the town limits, there is still a narrow fringe of the original forest along the river and its tributaries. Here *Macrolobium macrophyllum* is a tree fifty or more feet high as is also *Calpocalyx brevibracteatus; Bussea occidentalis,* a member of the Leguminoseae as are the two preceding species, grows to a height of eighty feet, and when in full bloom is covered by a mass of rich yellow flowers that make the tree stand out among all the rest. The erect reddish-brown pods that follow contain seeds that are eaten by the natives. Other and taller members of the same family are also present but unfortunately not in flower. Of the lower trees, not exceeding twenty feet in height are *Strephonema apolloniensis*, *Leptaulus daphnoides*, *Glyphaea laterifolia*, a bush about ten feet high, branching at the base, and bearing thin tapering okra-shaped fruits, and *Caloncoba echinata* a tree fifteen feet with white caulicolous flowers that are subsequently replaced by spiny ovoid fruits. Among these trees and producing conspicuous lianas are *Acacia pennata* and *Milletia melanocalyx* with its panicles of white flowers. Further back from the river, *Dichapetalum scabrum*, producing its small creamy-white flowers in the racemes at the axils of the leaves, also is a liana or better still, a woody vine. In the brooks flowing through the open secondary growth, the alga *Batrachospermum* is again abundant, while less abundant and apparently more restricted in its occurrence is *Nitella* of the green algae, in company with which is a plant that strongly resembles species of *Najas*. Among the numerous species of sedges and grasses that inhabit the swampy border of such brooks, *Dryopteris gongyloides* is a not uncommon fern, nor is *Ceratopteris thalictroides.* Of the grasses, *Setaria sulcata, Sorghum arundinaceum, Paspalum scrobiculatum* which also grows in drier places, *P. auriculatum, Chloris breviseta, Sacciolepis interrupta,* and several other species are conspicuous inhabitants of the same habitat. *Jussieua acuminata* and a species of *Dissotis* are less frequently met. One of the conspicuous aquatic plants is *Otellia* sp. a member of the Vallisneriaceae. This appears to be very rare and when found, it occurs only in sluggish brooks that drain the swamps, and in which there is a heavy deposit of mud. The three-parted flowers of this species are yellow; the leaves are broadly linear, reddish, and submerged.

Some of the swamps of the upper elevations, that is, those formed between the hills, and which are rather narrow and limited in size, support the growth of *Anthocleista nobilis(?)* in fairly dense stands. The trees with their greenish, slender, and obtusely spined trunks, reach a height of thirty or forty feet. The branches are terminated by clusters of two-foot long, broadly lanceolate leaves and from the center of the clusters are produced the cymes of white flowers that are about a half inch in length. Adjoining these swamps, or even remote from them, at all events in drier situations, a related species of *Anthocleista* is locally abundant. Although resembling the preceding species in a general way, it is distinct, not only in its habit, but in other morphological characters as well. The cymes of flowers are much larger, the fruit is upright on an erect cyme instead of drooping, and the leaves are larger. These two species were seen during the course of the Expedition, only in an area roughly bounded by Suahkoko on the one side and Kassata on the other. An additional species of the same genus was subsequently collected near Pehata (Paiata). The natives use a tea made from the bark of *A. nobilis(?)* to cure stomach troubles. According to Baker,[1] there are sixteen species of *Anthocleista* in tropical Africa of which three occur in Upper Guinea, although none are cited as coming from Liberia.

The second growth has, in addition to those previously mentioned, the following bushes: *Tetrorchidium didymostemon, Alchornea cordifolia(?), Uncaria africana, Mareya spicata, Macaranga huraefolia, Phyllanthus capillaris* and *Randia* sp. The last species, an erect bush, seven feet tall, produces fruits that are highly prized by the natives. The flavor of the fruit when ripe is much like that of cranberries, especially frost-bitten ones, though less tart. They are, because of their acid quality, especially delicious when found along the path during a long hot walk.

Such trees as are present in this formation, seldom exceed forty feet and apparently are remnants of the original forest. Thus *Cathormion altissimum,* a leguminous tree twenty-five to thirty feet high, grows at the edge of the rice fields in relatively low ground and not far from the primary forest. The seed pod of this tree is flat and coiled to form a helix. *Parinarium Kerstingii* is perhaps more favored by the open conditions provided by the secondary growth.

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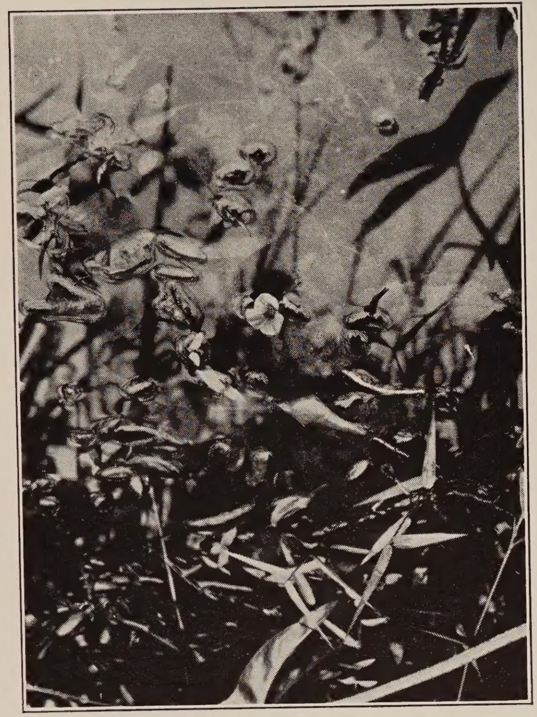
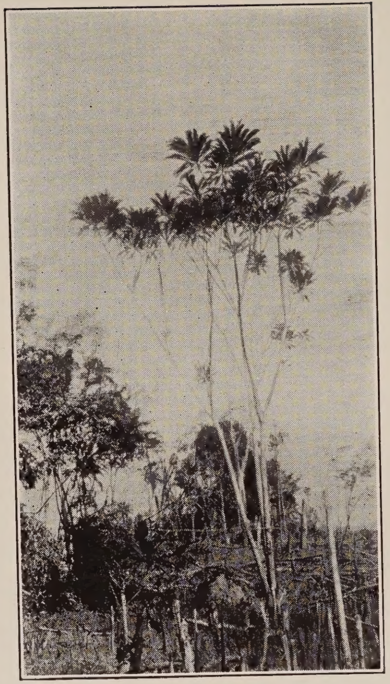
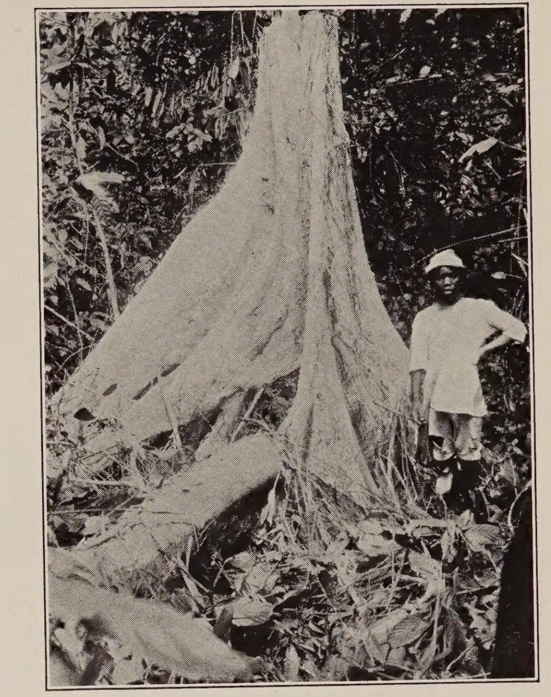
[1] Baker, J. G., in Thiselton-Dyer: Flora of Tropical Africa, 4:537–542. 1903.



No. 420. — *Otellia* sp. in slowly flowing brook near Gbanga



No. 421. — *Anthocleista* sp. near Mwesi



No. 422. — Buttressed trunk of *Chrysophyllum* sp. In swamp at Gbanga

Cola nitida is apparently a remnant of the original forest that has been spared because of the value attached to the fruit by the natives. Certainly the trees are not numerous, and from the fact that two related species, *C. acuminata* and *C. lateritia* grow in the original forest, and since also the tree at Paiata grows luxuriantly in the shade of the taller trees, it seems evident that *C. nitida* cannot be considered a typical species of secondary growth. The same remarks also apply to many of the vines that are seen in this formation. Thus, while *Combretum platypterum* and especially *C. grandiflorum* appear to thrive in the open, *Hippocratea Loeseneriana* and *H. Welwitschii* appear to be more typically forest types. At all events, when found elsewhere, *H. Loeseneriana,* occurs in heavy forests. Two additional species of *Mucuna, M. flagellipes* and *M. urens* are present in the second growth. The latter species, characterized by its large yellow sweet pea-shaped flowers, is used by the natives in the manufacture of pottery to make the utensils black. The slender cucurbitaceous vines of *Physedra longipes* and *Melothria capillacea* appear to grow equally well in secondary growth and in openings in the original forest. The little vetch, *Abrus canescens,* is an inhabitant of the roadsides. A liane that grows over the higher trees of the second growth, later found at Pehata in the original forest, has recently been described as *Calpocalyx sericeus* by Hutchinson and Dalziel.[1] It is characterized by its one to one and a quarter inch thick, hexagonal stem; its grayish leaves; and its dull orange flowers that are arranged on spikes that are frequently clustered and subtended by grayish, silky, bi-pinnate leaves. The flowers give off a very delightful apricot fragrance that can be detected from a distance.

The more common grasses of the secondary growth of the drier soils are *Eleusine indica, Acroceras oryzoides, Paspalum conjugatum,* and *P. scrobiculatum.* The last species also occurs in the more moist situations. All are found among the more recent growth and either in the open or in thickets. Of other herbaceous types, *Piper umbellatum* with its large round leaves and its grayish-white dense spikes of flowers, makes an occasional showing; less conspicuous are the plants of *Vigna unguiculata* and *Honckenya minor.* The last species, growing in rather dry exposed places, in contrast to *H. ficifolia* that often is almost six feet tall, attains a height of only fourteen inches. In spite of the difference in stature, their flowers make their generic relations clear.

Adjacent to the town of Gbanga, also known as Joquelli Gbanga, there have been conserved about five hundred acres of the original forest that apparently serve as a game preserve. Within the forest is found both the original swamp flora and also that of the upper levels. The swampy area is traversed by an intricately winding brook that leaves islands of mud or sand and makes minute bayous. In such shaded places the common herbaceous plants belong to the family Marantaceae; members of the Commelinaceae, such as *Palisota* spp. are also fairly well represented, while such species as *Renealmia maculatum, Leptaspis conchifera,* a grass, and two or three species of *Chlorophytum,* and

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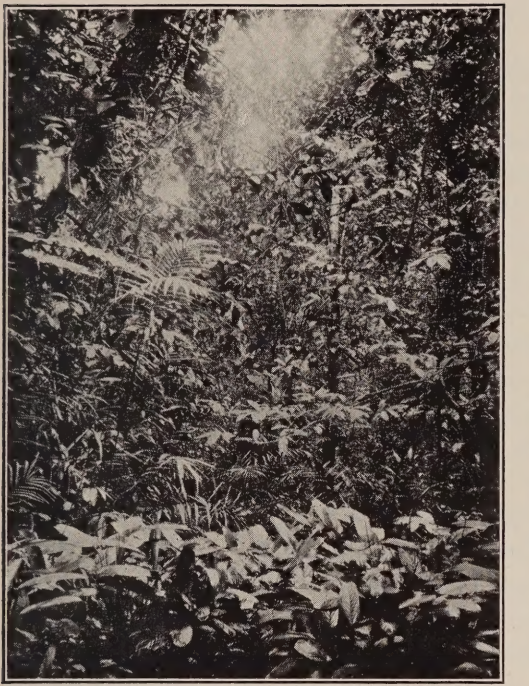
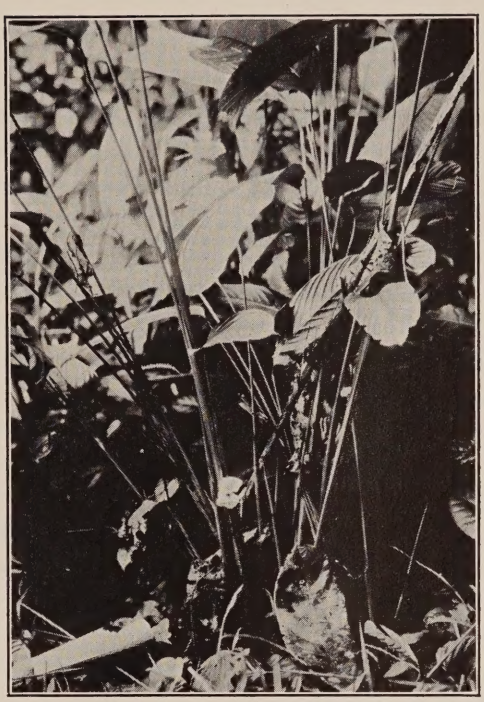
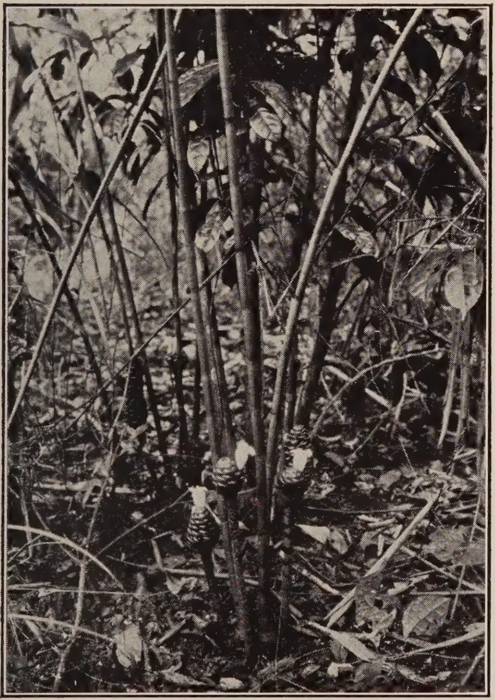
[1] Hutchinson, J., and Dalziel, J. M.: Tropical African Plants VI. Kew Bull. Misc. Inform. 1928 (10): 400. 1928.



No. 423. — Swamp forest at Gbanga. The leaves of a marantaceous plant are in the foreground



No. 424. — A marantaceous plant of swampy habitats



No. 425. — A white flowered zingiberaceous plant of the upper forest. Gbanga

No. 426. — A view in the upper forest at Gbanga

several ferns of which *Pteris Mannii* is as frequent as any. *Piper guineensis,* used by the natives to flavor their rice, grows very luxuriantly, if not in great numbers, up the trunks of the higher trees, as does *Dichapetalum pallidum.* Lianes are few in number and for the same reason conspicuous. Of these at least three species were collected: *Dalbergia oblongifolia, Oxymitra gracilis,* and *Calpocalyx brevibracteatus.* The last species, growing in this locality is a liane, yet along the river's edge it is a slender tree thirty to forty feet high. The forest trees through which only diffuse light penetrates to reach the ground, are essentially the same as those that grow along the edge of the river, although a member of the Leguminoseae that has pinnate leaves and of which the flowers are densely arranged to form slender spikes four to seven inches long, is a dominant tree in the wetter places. It reaches a height of about two hundred feet and then its heavy limbs are so branched that a flat-topped crown is produced. The bole of this tree, grayish and relatively smooth, is about two and one-half feet in diameter at shoulder level. Another tree (No. 422) with a somewhat stilted and distinctly buttressed base probably belongs in the genus *Chrysophyllum.* On the upper limbs of this tree, an orchid belonging to the genus *Bulbophyllum* grows in great abundance and, incidently, serves as feeding ground for the white-faced monkeys. It is difficult to make out whether it is the young shoots that are eaten or the insects that are found among the roots. At the upper border of the swamp, the trunks of the trees are draped by the foliage of the climbing aroids, *Rhektophyllum mirabile* and *Cercestis* sp. Here also grow such low trees as *Cola lateritia* and *Antidesma membranaceum,* twenty to forty feet high.

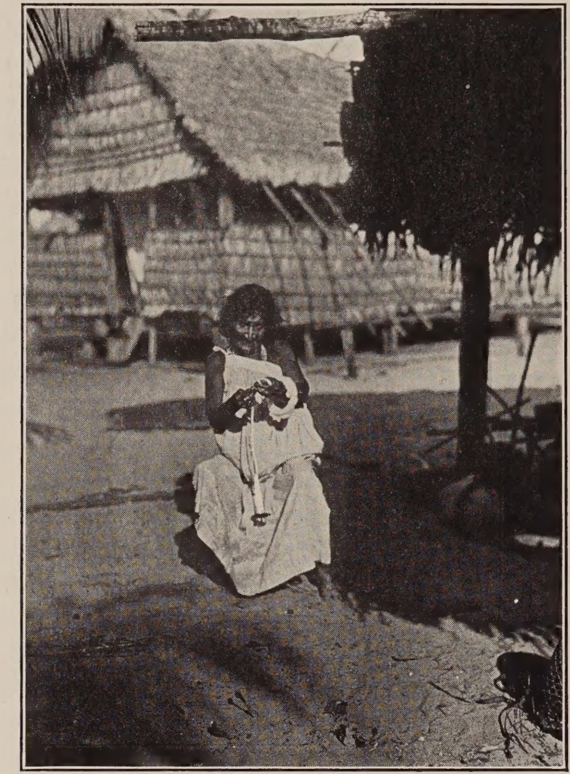
The trees of the upper levels are not as tall as those of the swamps. They seldom exceed one hundred and twenty-five feet. Also the foliage is less dense and thus light is permitted to reach the forest floor in greater quantities, thereby favoring the growth of a greater number of low trees, bushes and herbs. Here *Afrodaphne euryneura* attains a height of fifty feet, and *Cola acuminata* about thirty-five feet. A species related to *C. acuminata,* and previously found on the hilltops near the Du River is *C. pachycarpa.* There are many species of trees or shrubs that do not reach twenty feet. Of those determined to date, *Acioa Barteri* and *Uvaria spectabile* are usually that tall, but the remainder are between six and fifteen feet high. To this class belong *Popowia Vogelii, Antidesma venosum, Microdesmis puberula,* and *Rinorea liberica,* the last a member of the violet family. Two of the more conspicuous forms are *Ouratea flava,* an abundant and showy species with large suberect panicles of yellow flowers, and *O. elongata,* a plant worthy of cultivation in any greenhouse. This latter species is less bushy than its relative. The stem is four to five feet long, simple, and erect. On the upper part of the stem are produced large, slightly recurved, lanceolate leaves, at the base of which humus collects and serves as a source of nutrition, for roots that arise from the base of the petioles, penetrate it in all directions. The flowers of this species are also borne in a large panicle, sometimes three or four, but the panicle in this case is drooping and is surmounted by a pair of leafy bracts.

Kolobopetalum leonense with its large, shining, heart-shaped leaves, *Rhigiocarya racemifera,* and *Hippocratea Thomasii* are the conspicuous woody climbers. The latter is especially conspicuous since it grows at the edge of openings and climbs up the tall trees. It is more striking because of the fact that it produces numerous panicles of ochraceous-orange flowers which give off a very delightful fragrance. *Coccinia cordifolia* and *Melothria tridactyla,* both herbaceous climbers belonging to the Curcurbitaceae, also grow here, but apparently in smaller numbers and less luxuriantly than in the open.

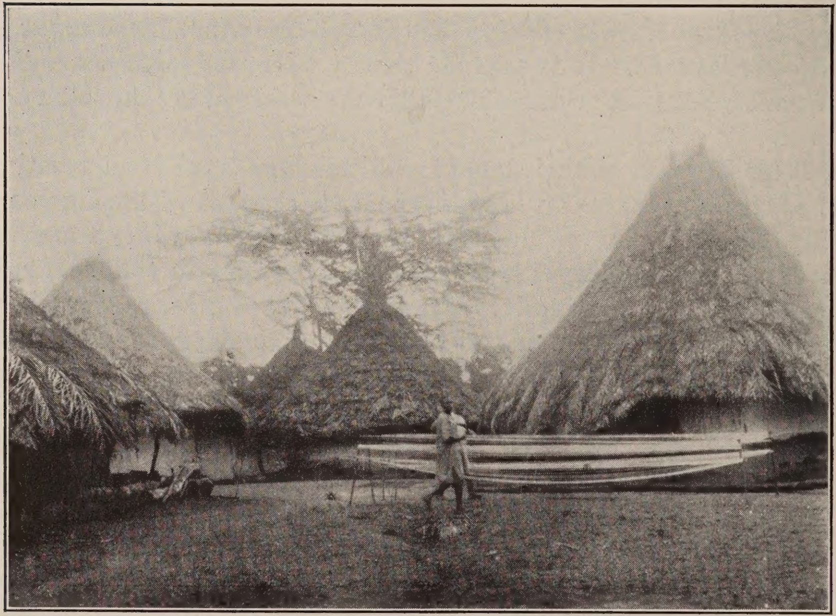
There is *Nephthytis constricta* and one or two additional terrestrial aroids that thrive in the moist, gravelly, and shaded forest floor. The gravelly, yet clayey banks of the brooks support a luxuriant growth of four or five species of *Selaginella. Marattia fraxinea* also occurs in this same habitat, in fact appears to be confined thereto, for it was previously collected near the Du River under identical conditions. Of the grasses collected, *Guaduella marantifolia* and *Olyra latifolia* both large-leaved species, and *Pseudoechinolaena polystachya,* a small delicate species, should be listed. Many other herbaceous types and a few conspicuous bushes are also present but lack of names prevents their mention.

In waste places about the town, apparently not under cultivation, yet eaten by the natives, are several solanaceous plants, among which are *Physalis peruviana,* two species of *Capsicum* that furnish the desired gastronomic thrill, and two species of *Solanum.* One member of the latter genus is sold in the market for greens and is greatly appreciated. The other member resembles in the form of its fruit, an immature egg plant. The sword bean is cultivated on a small scale. Of this only the leaves are eaten, not the young green pods. The true weeds of little apparent value are represented by *Acalypha ciliata, Eriosema glomeratum, Sida carpinifolia, Heliotropium* sp., *Amarantus spinosus* and *Cassia occidentalis.* It is possible that *A. spinosus* furnishes a green, and *C. occidentalis* a laxative. Species of *Cassia* are observed in the vicinity of nearly every town.

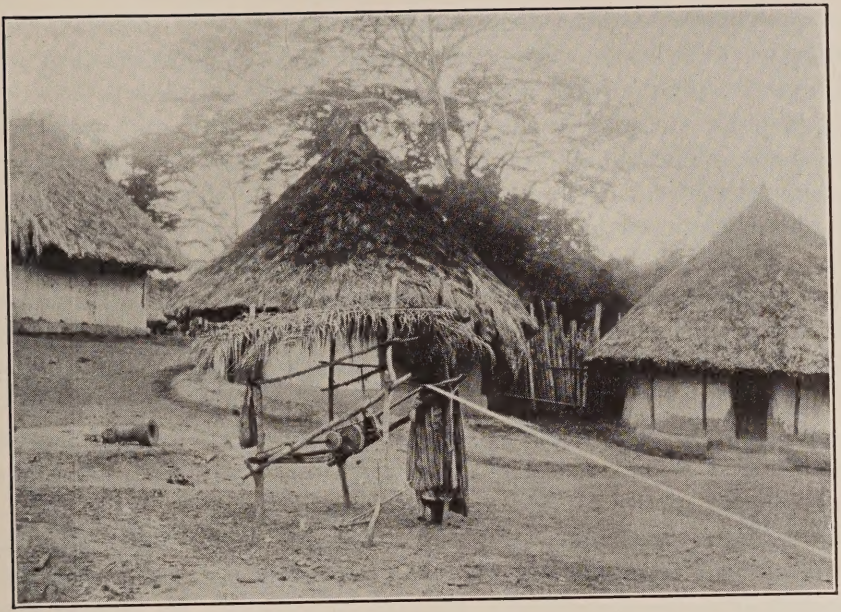
Rice fields because of their extent and numbers have been mentioned frequently, partly to convey an idea of the vast amount of land given over to the cultivation of that crop, but also because rice is the bread and butter of the natives, to say nothing of it as a source of income to the local chiefs who have a monopoly of this produce. One cannot but wonder at Sir Harry Johnston's words after one has seen and passed through the many and large fields. He states that "the denseness of the interior woodland is at once a guarantee of unexploited wealth and a terrible hindrance to the civilization of the country." The first part of his statement is undoubtedly true, but the second part, if agriculture is considered the backbone of civilization, certainly cannot be substantiated, at least at the present day, for the natives, by their own hands have converted thousands of acres of land into productive areas. It seems that lack of easy transportation and on that account lack of contact with the outside world is what determines the advance of civilization. At all events, in this locality the people have reached the stage of development that makes



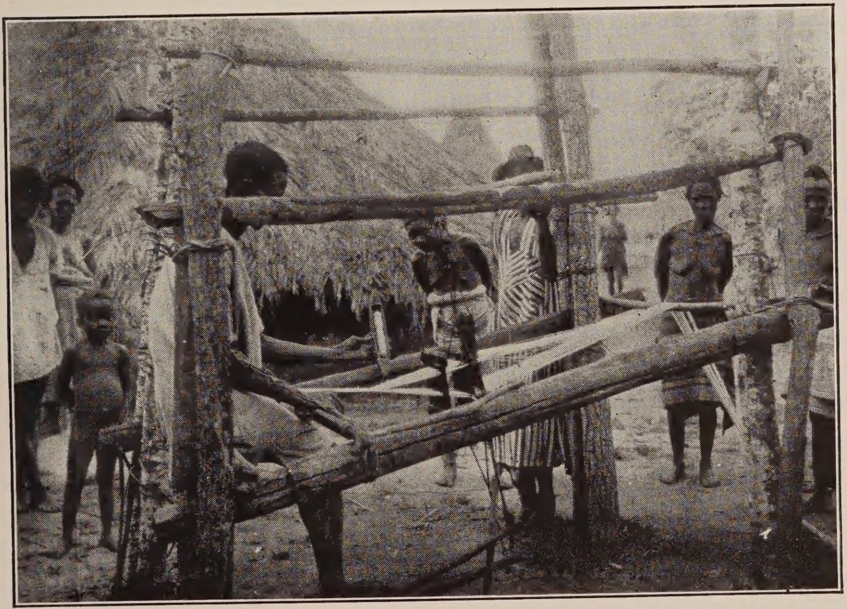
No. 427. — Spinning cotton thread. Photograph taken on the Upper Waijombo River in Surinam, South America



No. 428. — Drying dyed cotton thread, Gbanga



No. 429. — A native loom. The thread held taut by a heavy stone to the right and as it is made into cloth strips, is wound on the drum on the frame. Gbanga



No. 430. — A closer view of a loom. The spindle in the man's left hand is passed back and forth between the two series of thread, the position of which is alternated by working the treadles. Kassata

obvious the value of storing their surplus stock. To do this, the rice is put up in bundles that are just large enough to make a good load for one man. These bundles resemble large cocoons and are made as follows: the fronds of the Raphia palm are split in half along the main rhachis and then cut to the appropiate size. The pinnae are interwoven at the ends so that a loose rectangular basket is formed in which the two halfs of the rhachis form the bottom corners and the interwoven ends of the pinnae form the ribs of the two upper corners. One end of the basket thus formed is left open. This basket is then lined with a layer of banana leaves and inside of these is placed another layer of the leaves of *Anthocleista.* A definite amount of rice is poured into the doubly-lined basket and the process is then repeated in reverse until the basket is covered and sealed by lacing in the pinnae of a single unsplit frond of the palm, cut to proper size. The baskets are then stored away while the leaves are still green, and if not used up in three or four months, they are opened and the rice is allowed to dry in the sun before being repacked.

Another industry, though on a less imposing scale, is furnished by the cotton plants that grow around the village or at the edges of the rice fields. This is the manufacture of cloth. The cotton is ginned by pulling it through a comb-like affair and is then, after drying, spun in the same manner as previously seen employed by the Indians of the upper Waijombo River in Surinam, South America. The dried, ginned cotton is roughly formed into a long, loose roll which is passed around the forearm one or two times, over the wrist, and then down between the forefinger and thumb. A long conical, top-shaped spindle is then spun and that twists the cotton into a tight thread, the thickness of which is nicely controlled by the manipulations of the thumb and forefinger. The resulting thread, remarkably uniform, is either used as it is produced, or else is dyed blue. There are two sources of the dye; one the leaves of a tree of which only an imperfect specimen could be obtained and therefore not identified, the other source is *Indigofera suffruticosa,* named "garnah" by the Kpwesi tribe. Although the exact manner of dyeing the thread was not observed, the results nevertheless are very uniform and apparently non-fading. The dyed thread is dried in the sun where it is wound around three upright sticks, as shown in the photograph (No. 429). Finally it is woven on the loom (Nos. 429, 430), and the resulting cloth is in long strips six or seven inches wide, which in turn are sewn together to make the various and durable articles of wear.

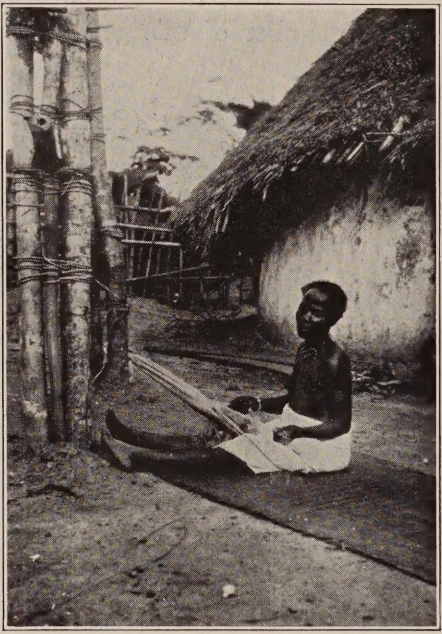
Mycophagy, judging by the paucity of agarics, is not a very substantial means of obtaining energy. A white species of *Volvaria* and also a species of *Collybia(?)* enter into the menu of the natives on occasion. The latter appears to be very highly prized, judging by the exclamations of delight given vent to by the natives when they discovered a specimen, and the considerable disapproval expressed when the same specimen was confiscated for scientific record. There is small wonder at their disapproval, for the species is one that is solitary and at the same time appears to be rare, though its scarcity is made up for by its size, — twenty-two centimeters in diameter. Of the non-edible fungi, *Cordyceps myrmecophila(?)*, a parasite on the large black ants that was previously collected in small numbers among the forests near the Du River, occurs here in almost epidemic proportions. Five or six ants, clinging to a single stem of a plant, were observed with the fruiting bodies of the fungus growing out of them. In a morning, as many as fifteen or twenty could be collected. A specimen each of the *Cordyceps* growing on the wasp *Eumenes maxillosus* var. *tropicalis,* and on a caterpillar larva, were also collected. Members of the genus *Xylaria* and *Polyporus* were also well represented, as were also two species of the beautiful little cup fungi, *Cookeina.* A new species of *Choanephora,* now being investigated by Professor William H. Weston of Harvard, was collected on the leaves of *Carica papaya* where it caused considerable damage to the leaves and appears to be the cause of their premature dropping. This is the first time that a member of this genus has been reported on this host, and from tropical Africa.

Gbanga to Paiata (Pehata)

Leaving Gbanga, the path goes up and down through slightly rolling country that is covered for the most part with either secondary growth or rice fields. Only occasionally are there small patches of the original forest, and it is at the edge of one of these that the orchid *Megaclinium* sp. was found growing on a fallen log, fully exposed to the direct rays of the sun. This is a rather remarkable occurrence, since the species as a rule, grows in the shade of the tall trees on which it is an epiphyte. Occasionally there are sandy valleys in which various species of grass form swales. About twenty minutes beyond Wumbi or Mwesi, as the town is variously called, there is a long hill that rises to twelve hundred feet above sea level, and some seven or eight hundred feet above the valley. From this point onwards the hills, some of them circular in outline, others elongate, become more numerous, two of them reaching an elevation of 1,450 feet. On the last of these is situated the town of Kassata which makes a very picturesque crown. In the valleys and on the lower levels of the hills, *Anthocleista* is rather abundant, as are also the two palms *Raphia vinifera* and *Elaeis guineensis.*

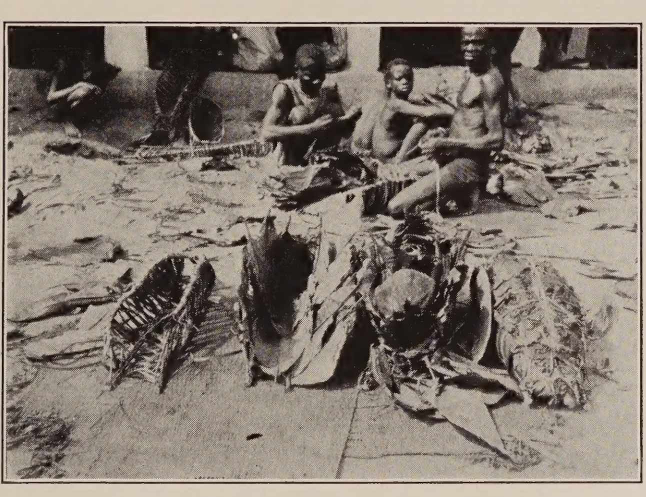
Two days are spent in Kassata while porters are being commandeered to carry our loads. On the second day, we make an attempt to reach a nearby mole hill and with success, although with difficulty for the secondary growth is very dense and troublesome, especially when the patches of the climbing saw grass, *Scleria* sp. are encountered. In this growth the genus *Ficus* is represented by three or four non-parasitic species. The grass *Manisuris* is here seen for the first time, growing in wet openings among the low bushes. One of the prettiest plants is the melastomaceous *Calvoa monticola* that grows in the shade on rocks at the edge of a brook that has its source in the forested hilltop above. The delicate green leaves and the beautiful pink flowers, with the rocky background, make a very enjoyable sight after a struggle with the rather monotonous bushes of the second growth. In the forest that caps the hill, there is disappointingly little of interest aside from the maiden-hair fern, *Adiantum lunulatum* and so we return to town.

Aside from the rice fields in the vicinity, the gardens in the town are small and on the brow or else on the steep, terraced hillside. In these are raised such crops as the pineapple; *Phaseolus lunatus*; sorghum of a kind; *Colocasia* sp., of which the corms are eaten; *Ipomaea batatas,* or yam; *Hibiscus esculentus* of which the young fruits are eaten; okra, cultivated not only for its fruit, but also for its leaves which furnish greens; two species of *Capsicum;* a small tomato, *Lycopersicum esculentum;* two species of *Solanum;* cassava; and a fleshy-leaved chenopodiaceous vine that would probably make a very fine substitute for spinach. Tobacco is also grown, but in such small quantities that the supply is not sufficient to satisfy the local demand of the material for snuff and for smoking. Of the fruit trees, oranges and limes, two species of *Musa,* the plantain and banana, and the breadfruit tree are present in small numbers. The *Cola* tree and a species of *Ricinodendron,* not in cultivation, add variety to the menu. Only the kernel of the fruit of *Ricinodendron* is used; the capsule is removed by boiling and then cracking. The freed kernel is then toasted and salted, if salt is available. The resulting product tastes very like cashew nuts, but is very oily.



No. 431. — Method of packing rice for storage. Gbanga

Just as at Gbanga, cloth is made from locally raised cotton. In addition, there is another industry in which the people of this district appear to excel. That is the manufacture of bags out of the fibers obtained by stripping the vascular tissue from the fronds of the Raphia palm. The resulting bags, used in the place of trunks or to carry tobacco and other necessary articles, are very durable, and although many are quite plain, others are elaborately decorated



No. 432. — The manufacture of raphia bags. Kassata

No. 433. — A view to the south from Kassata to show the hilly nature of the region. The light square patches are rice fields

by geometrical designs worked in with dyed strands. The colors of these strands are usually yellow, red, blue and black.

From Kassata to Yangi the country continues to be steeply rolling and several hills, well forested, are traversed. Most of the hills reach an elevation of ten to eleven hundred feet, although the village of Yangi is located on one 1,450 feet high. In this town, oranges, bananas, cassava, and peanuts are raised for local and apparently temporary needs. Around the gardens of this hill-top village, there are fences made by sticking lengths of *Erythrina senegalensis* into the ground, and these have taken root, grown, and bear the conspicuous scarlet-red flowers.

From Yangi the descent is steep as may be judged by the fact that we descend, according to the barometer, six hundred and forty feet in twelve minutes, when we reach the more or less level valley in which Bakratown is situated. The immediate neighborhood of this town is covered by secondary growth of the usual type. The climbing fern, *Lygodium* sp., grows over the lower bushes, as does the leguminous vine *Milletia Zechiana* and *Mucuna pruriens.* A tree, fifteen to twenty feet high, not previously or subsequently seen, is *Myrianthus serratus* which very closely resembles *Artocarpus incisa,* especially in respect to its fruit, which, however, is somewhat smaller. This fruit, I am told, is eaten by the local Mandingo people, but not by the Vai. Along the path in exposed places, the four-foot tall plant of *Desmodium adscendens* and *Cassia Kirkii* are of common occurrence. On the north slope of a low hill, in secondary growth where humus has collected, grows the leafless gentian of the subfamily Laeiphameae. The small white flowers are borne singly on slender stems that do not exceed six inches in length. In the same habitat two interesting fungi also occur, — an ochraceous species of *Clavaria,* and a species of *Geoglossum,* thus making the second locality in Liberia for a representative of this genus.

The road from Bakratown, for the first hour, passes through secondary growth, and then, for the greater part of the distance, through tall forests, some of them indeed very beautiful and apparently untouched. Such places appear to be very favorable for the persistence of *Tetracera potatoria,* a liane famous for the fact that when the stem is cut it furnishes pure water. A section of the stem, seven to eight feet long and ten to fifteen centimeters in diameter gives up about a half a glass of colorless and odorless water in which there are no raphides. In the more open parts of the tall forests, and growing on gravelly soil is a species of *Eryngium* known under the Kpwesi name of "goomanderri." It is used for reducing fevers by rubbing the leaves over the body.

Near two abandoned villages there are fairly large fields of sugar cane that have apparently been allowed to grow of their own accord in recent years. A hasty examination of this field gave no evidence of the presence of mosaic disease, although one case of "yellows" was observed. At the edge of these fields is a thicket of *Dichrostachys glomerata,* a low tree that has not been seen since Monrovia was left behind.

Beyond the town of Fetoma where *Xylopia aethiopica* is collected, the forest continues, though there is an occasional break in it where rice fields are established. The terrain continues to be rolling and the elevation seldom exceeds eight hundred feet until Bonuta, which is situated on a flat hilltop at nine hundred feet elevation.

At Bonuta where we spend two days, *Waltheria lanceolata, Cassia occidentalis, Indigofera macrophylla,* all herbs; *Hippocratea Thomasii* and *Dalbergia saxatilis,* vines; and *Leptaulus daphnoides* a tree fifty to sixty feet high, and *Macaranga Barteri,* fifteen to twenty feet high, were collected.

As usual, rice is planted outside of the town. Within the limits of the town in small gardens, *Colocasia* sp., cassava, a few pineapples and peanuts, are grown. Here, as is also true of Bakratown, much more appears to be made of the oil palm. The oil is used for cooking, and also to smear over the wounds made during the process of scarification.

Between Bonuta and Paiata, the land appears to be almost level and the soil rather sandy. About four-fifths of the distance is in fine forests, the remainder either in second growth or rice fields. The forest appears to be much the same as that already traversed, although one or two new trees and several vines are seen. About half way to Paiata, the screw pine, *Pandanus* sp. not seen since the brackish waters near Duport, grows in a fresh-water swamp. The species is not as large nor is it in as great numbers as the one near the coast, so that there are grounds for speculations as to the identity of the species and as to the manner in which it reached that locality.

Paiata, seven hundred and forty feet above sea level and about seventy-five feet above the St. Paul River, is on a flattened ridge that extends some distance back from the river. Along the edge of the river there is a fringe of bushes among which are such species as *Ormocarpum guineensis* and *Hymenocardia africana,* the latter the more numerous of the two. Behind the lower fringe are tall trees, the majority of them leguminous, and some of them sending their stout branches out over the water. On such branches grow two species of orchids, one related to *Bulbophyllum imbricatum,* the other to *B. rupinicola.* Here also grows one of the few epiphytic and herbaceous members of the Melastomaceae, *Amphiblemma cymosum,* its characteristically veined leaves reddish below, but with a beautiful metallic blue sheen above. *Xylopia Vallotii* also occurs along the river edge where it is a spreading tree about forty feet high. This species also occurs in the original forests away from the river. It is known by the Kpwesi tribe as "sibi," and the fruits are eaten. Under the taller trees, *Manniophyton africanum,* a common bush of the secondary growth around Gbanga, grows into a straggling tree twenty-five or thirty feet tall. A low, semi-ligneous species of *Dracaena,* and also a small climbing relative of the rattan palm is occasionally seen on the flat bushy banks of the river. In moist openings near the river, an unusual species of *Scleria* was discovered. It grows to a height of six feet and differs from any species of the genus that have been seen previously, by its tuberculate fruit, its prominent ligule, and the characteristic constriction of the leaf blade near the base. Of the vines that drape the taller trees along the river's edge, two have been identified as *Lingelsheimia gilgiana* and *Chlamydocarya capitata.* The most beautiful of the vines, as well as the most fragrant, is the apocynaceous *Landolphia* sp. that bears large numbers of conspicuous white flowers.

On a muddy flat bordering a creek and which is submerged when the river is at its height, grows a species of *Cuviera,* quite distinct from that collected at Monrovia. It is a tall bush or straggling tree about twenty feet high that branches four feet above ground and tends to become straggling. The fruit when bruised or cut gives off the odor of oil of wintergreen. It is not on that account that the species is of interest, rather because of the fact that it is myrmecophilous, the ants being harbored in the green wood of the young shoots. In association with *Cuviera,* and conspicuous because of the zig-zag growth of the slender branches, is *Tetrorchidium didymostemon.* The upper border of the mud flat is fringed with a dense thicket of zingiberaceous plants.

In the original forest, *Calpocalyx brevibracteatus* attains a height of eighty feet or more, and *Cloaxylon hexandrum,* sixty feet, as does also a species of *Anthocleista,* while *Milletia lucens* reaches forty feet, and its relative, *M. Thonningii,* twelve to twenty feet. There are numerous species of the undergrowth and of these *Ouratea flava* is by far the most abundant. Less frequent are *Salacia leonensis, Olax Linderi, Ouratea Schoenleiniana, Tetrorchidium didymostemon,* and *Croton nigritanus,* the last a species which attracts attention because of the flaming scarlet color of the older and dying leaves. *Dorstenia* sp., a relative of the fig, is rather abundant, but because of the inconspicuousness of the peculiar green, flattened flower receptacle, often escapes notice.

Of the vines and lianes, *Rhigiocarya racemifera, Hymenocardia lyrata* with its peculiar two-winged fruit, *Stephania Dinklagei,* and *Hippocratea velutina* are not uncommon. *Leptoderris fasciculata* and *Hippocratea Richardiana* produce stouter and longer vines that climb over relatively tall trees. *Atroxima liberica* appears to be a cross between a tall bush and a vine, with the former characteristic predominant. It starts out as a bush, but the lower branches have a tendency to become so elongate as to require support from neighboring bushes. An additional species of *Draceana* has this same tendency. At first it is an erect woody herb but soon it becomes necessary for the plant to depend on its neighbors for support.

On the forest floor in the dense shade, *Streptogyne gerontogaea, Milbraedia paniculata,* the former a grass and the latter a member of the Euphorbiaceae, both manage to survive despite their none too liberal allowance of light. *Rhipsalis,* a cactus and the only representative of that family of the western hemisphere in tropical Africa, hangs from the upper branches of trees upon which it is epiphytic. Another epiphyte, the staghorn fern, hitherto not observed, grows here in relative abundance.

The second growth is of the usual type with *Haronga madagascariensis* and the common climbing saw-grass only too frequent, and these are seconded by *Antidesma laciniatum* var. *membranaceum. Dichapetalum pallidum* grows over the lower trees to a height of thirty-five feet while *Rhigiocarya racemifera, R. Chevalieri, Celosia laxa, Psophocarpus palmettorum,* and *Iodes liberica* climb over the bushes. *Cucumeropsis edulis* also is scandent but appears to occur

No. 434. — The St. Paul River above Paiata

No. 435. — The St. Paul River at Nyanga. The tall tree on the right is the silk cotton tree

only in the vicinity of the town. *Jatropha curcas,* stuck into the ground to make fences, readily takes root and produces the leaves which for some reason are used to cover rice while it is cooking. According to Johnston[1] the plant is also used as a purgative and emetic. It may be for this reason that the leaves are used in cooking rice, namely to counteract the effect of the large amounts of rice that are eaten. *Triumphetta,* a genus common in the region above Stanley Pool on the Congo River, is here represented by *Triumphetta cordifolia* that grows in the secondary growth at the edge of the forest. Of the weed-like plants that grow around the town, the following may be mentioned: *Desmodium lasiocarpum, D. paleaceum, Cassia podocarpa, Sida cordifolia,* and *S. veronicifolia,* the last known by the Vai tribe as "Mwelli." The natives in this region use *Hibiscus rostellatus* in the same manner that those of the vicinity of Monrovia use *H. surattensis,* namely for craw-craw.

Rice is still the most important crop, although *Cola acuminata,* the cola nut of commerce, assumes an importance not observed elsewhere. This region appears to be especially favorable to the species for large numbers of trees grow in a state of semi-cultivation. That is, the tall trees that provide shade are allowed to remain, but the undergrowth is cleared away around the cola trees. Furthermore, when the trees come into fruit, they are protected from the ravages of itinerant natives by taboos or charms. Should one touch the fruit, these taboos are supposed to have been given the power to cause sterility in women, or loss of sight and other serious misfortunes in men. These charms are put on the trees by the medicine man under orders from the chief of the village. The reason for such precautions becomes evident when it is realized that the cola nut is an important article of trade between these people and the Mandingo tradesmen who bring with them brightly-colored cloth and trinkets for which the cola is exchanged. These same tradesmen penetrate into Liberia as far as Medina. It would seem that the cola nut could be made an important product for export if it were cultivated a little more systematically, and could furnish a source of wealth to the natives not only of the interior but also of the coastal region. But before such a state of affairs can come about, means of communication will have to be improved or otherwise the product will continue to be exported by way of the back door of the country with little benefit, except to the foreign neighbors.

Paiata to Banga

Paiata, our base camp for two weeks, and in an admirable region in which to collect, is left behind as we follow the trail almost to Nyalai through fine forests, and over slightly rolling country. Between Nyalai and Nyanga, on the St. Paul River, is a swamp in which were found *Maschalocephalus Dinklagei* and a species of *Balsamea,* the first and only one to be collected during the course of the expedition. In the town of Nyanga, a species of *Datura* with double white corollas, was found. The seeds of this were collected and then

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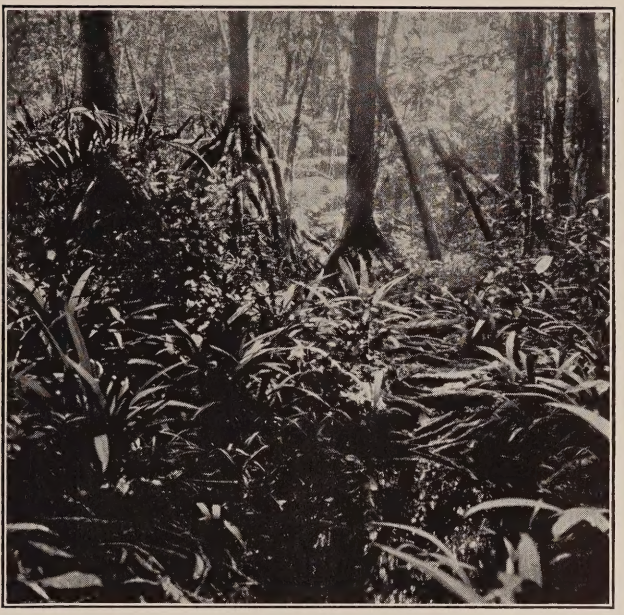
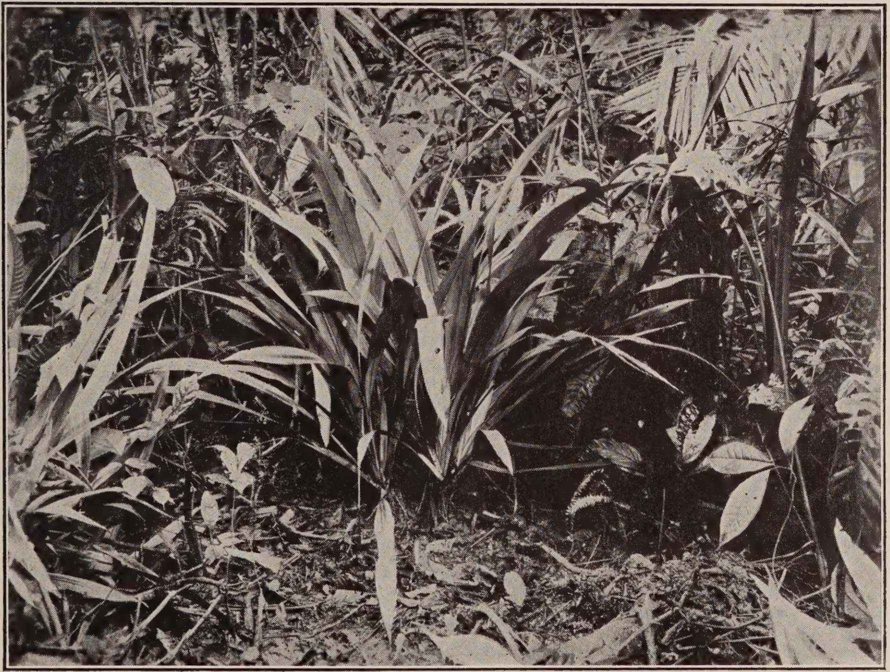
[1] Johnston, H. H.: *Loc. cit.,* p. 648.



No. 436. — A swamp between Bomboma and Moala. In the foreground are the leaves of *Maschalocephalus Dinklagei* and behind the stilted trunks of the taller trees



No. 437. — *Maschalocephalus Dinklagei* in swamp near Kaka Town

sent to Dr. A. F. Blakeslee at the Cold Spring Harbor station of the Carnegie Institute of Washington, at which station the genetics of the genus is being studied.

On the opposite side of the river from Nyanga, the country is heavily forested, and with the exception of low winding hills, is rather swampy. Beyond Kolubonu, the country is again higher and gently rolling; at the same time it is well forested. In some places there is an abundance of undergrowth with an admixture of lianes, in other places there is little undergrowth. It is in the latter type of forest that signs of elephants become fairly abundant, but, although several of these animals were reported in the vicinity, not one was seen. In this country, occasional outcrops of obscurely stratified rocks are observed. *Acioa scabrifolia,* a terrestrial orchid related to *Habenaria,* and a species of *Chlorophytum* are occasional plants, the last two preferring the gravelly soil in the shade of more or less open upper forests. Terrestrial ferns grow in small numbers on the shaded outcrops of rock, while members of the Commelinaceae appear to prefer the richer soil in more moist localities. Although the country is in general rolling, there are also several areas where the land is almost level and through which small brooks have cut their winding way. One or two swamps such as are typical of the tropics are also traversed, sometimes in water hip deep. In these the many trees form a dense cover overhead; some of the trees are provided with stilted roots. There are occasional bushes and predominant among the herbaceous types that claim the forest floor are two or three members of the Marantaceae with the picturesque broad foliage.

Maschalocephalus Dinklagei occurs abundantly wherever suitable conditions exist. As a matter of fact it can be said that in this region between Kolubonu and Fayapulu, the species is common. Particular attention was paid to the distribution of this plant because of its relationship to the South American Rapataceae, but more especially because of its reputed rarity. Judging by its distribution as observed by the writer and as shown by the black triangles on the map accompanying this Report, this species must be widespread in Liberia. It seems quite probable that the species will eventually be reported from Sierra Leone and the Gold Coast. Indeed, Herr Dinklage the discoverer of the species and after whom it is named, has collected it near Fishtown, and from there it is not a great distance to the Gold Coast. In spite of the widespread occurrence of the species in Liberia, there are a fixed set of conditions that determine its presence. The plant must have shade and the soil must be sandy and kept wet, though not necessarily flooded. The water of the soil should also be constantly changing. As a result of these requirements, the plant occurs mostly at the edges of swamps and at the foot of sloping ground where there is seepage and at the same time good drainage. At Duport where the plant was also found, all requirements were fulfilled excepting the presence of a hill. Even then there was a constant change in the soil water so the plants, though not numerous, could grow.

Oplismenus hirtellus, a grass, *Dissotis paucistellata* and *Dinophora spenneroides* of the Melastomaceae, and also a yellow-flowered member of the Commelinaceae grow in small numbers in the swampy, yet not excessively wet forests of the interior.

Between Fayapulu and Banga there are numerous ridges, some of them rather steep, all of them well forested. Just outside of Soe is the Tuma River that is twenty-five yards wide and which we have to cross. The crossing is made in a rather ingenious manner. A cable made of the stems of the rattan palm is stretched between two stout trees, one on either bank. The loaded raft is then worked across the stream by two men, one at the bow, the other at the stern, both pulling on the cable. It can well be imagined that a raft on rapidly-flowing water exerts a terrific strain on the cable, and the fact that it withstood such a test gives admirable evidence of the immense tensile strength of the stem of the rattan palm, not in excess of three inches in diameter, and of the men who ferry us across.

In the original forest on low land, *Napoleona Vogelii* occurs as a large bush, fifteen feet high, that branches three feet above the ground. The depressions in the ridges are populated by large numbers of marantaceous plants belonging to two or more species. *Maschalocephalus Dinklagei* is represented by smaller numbers of plants, and these are confined to the type of habitat already mentioned. Two ferns grow near the only waterfall encountered during the trip. One of them inhabits the rocks at the side of the waterfall, the other, *Hymenophyllum(?)*, is submerged and on the rocks below the waterfall. Once over the series of ridges, we encounter a fairly open and level valley traversed by a stream which has to be forded, knee deep, on fallen logs. The country again becomes rolling and forested, except for small rice fields, as we approach Banga.

Banga is on the government road that is eventually to connect Monrovia with the frontier, by way of Beli Yela. The town is situated on a hill, from various places on which, one can look out over the rolling country, although more steeply rolling than is the rule, and with one or two prominent hills of greater elevation than the surrounding ones. Through the description of a trip to one of these hills, known as Bo, northwest of the town, an attempt will be made to give an insight, though imperfect, as to the nature of the flora of this region. Descending the hill on which Banga is situated, we skirt a field of rice, at the edge of which grow one or two trees of *Pterocarpus santalinoides*, a species somewhat more than thirty-five feet high, and called "bartu" by the Vai who eat the beans. Soon we reach the tall original forest on the lower slopes of the hill. Here there is a variety of underbrush in which there are, many interesting shrubs, of which, *Heisteria parvifolia* is rather a common member. *Milletia Thonningii* forms a flat-topped tree about twenty feet high. Of equal height, but with drooping branches is *Ochthocosmus africanus*. *Macrolobium macrophyllum*, previously reported as a tall tree is found in full bloom when it has reached a height of only twelve feet, and four species of *Dorstenia*, seven to nine feet high, are found within a radius of a few rods. One of the pretty melastomaceous plants, *Dinophora spenneroides*, usually terrestrial, grows here epiphytically in the crotch of a tall tree, forty feet above the ground. According to my Vai boy, the fruit of this plant is eaten in order to cure "women sickness" or gonorrhea. There are numerous lianes, among which was a new species described by Hutchinson and Dalziel[1] as *Rhaphiostyles cordifolia.* Continuing through this forest we come to a stream at the edge of which *Napoleona leonensis* grows erect to a height of eight feet. On the lower limbs of a leguminous tree, such orchids as *Bulbophyllum maximum, B. melanorhachis(?),* and *Listrostachys pertusa,* and the fern *Nephrolepis biserrata* live epiphytically. In the wet, sandy soil, where the crown of the trees have parted and allowed light to reach, *Sauvagesia erecta,* a delicate little herb, a low, straggling bush of *Mussaenda,* and the tall climbing palm, *Calamus Barteri* are found. In the shade in wet places *Maschalocephalus Dinklagei* grows in small numbers, while there is an abundance of a species of the Marantaceae. As we proceed along the path, the large leguminous trees become more widely separated and as a result the pinnate leaves make a lace-like canopy in which irregular designs are made by the more dense foliage of other species. Protected from the direct rays of the sun, the delicate little *Burmannia* and the leafless, white-flowered gentianaceous plant grow rather freely. Bushes are rather few in number and only two or three lianes with their stout, climbing, snake-like stems are visible in the open spaces beneath the taller trees. One of the lianes is *Oxymitra gracilis.*

Leaving the beautiful forest, we enter second growth where *Haronga madagascariensis* is dominant over the other shrubs, although species of the Zingiberaceae not infrequently make dense thickets. An occasional vine of *Ipomaea* sp. that climbs over the low brush provides with its pink flowers very occasional bits of color, while the common climbing saw grass, *Scleria* is so rank that we have to detour around the patches.

Eventually we reach the tall forests on the hill of our destination and there there are many slender bushes six to seven feet high. Among these may be mentioned *Salacia Caillei* and *Olax Linderi.* In the moist, rich, black soil of the slope there is an herbaceous species belonging to the Commelinaceae that is about three feet high and has yellow flowers. *Daniella similis* is one of the conspicuous trees of the hillside forest. It reaches a height of more than one hundred and fifty feet, and has a smooth gray columnar trunk that is not branched for a considerable distance above the ground. The leaves are pinnate, but are obscured by the large numbers of purplish-pink flowers in panicles, and these make the crown one mass of color. When seen from a distance, the color is made all the more striking and beautiful against the background of dark foliage. At the top of the hill there appears to be a sorting of the species of the middle rank of tree, — that is, those between thirty and forty feet high, for two species stand out as being especially numerous. Of these *Garcinia polyantha* is the less numerous, although interesting because it produces clusters of flowers on short stems along the slender branches, and the flowers which are whitish, are characterized by the arrangement of the anthers in groups of fours. The other and more abundant species is *Lingelsheimia Gilgiana.*

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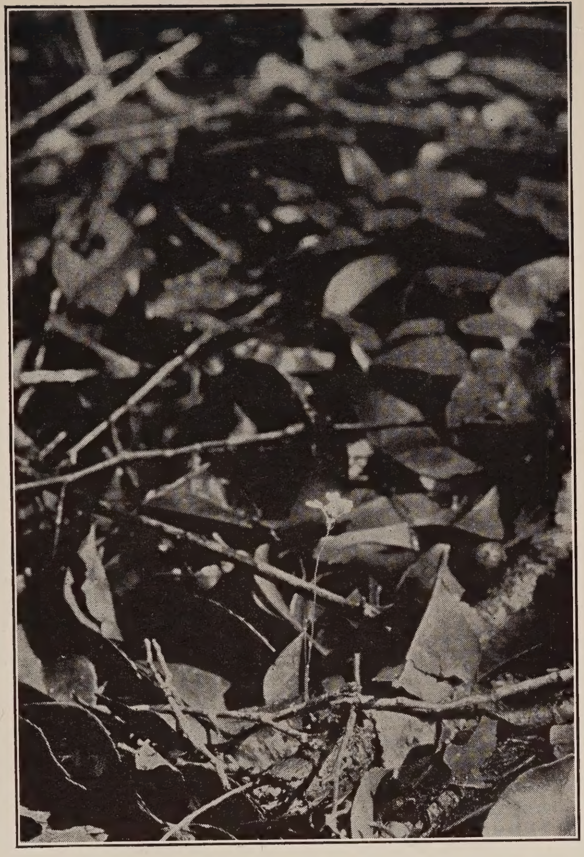
[1] Hutchinson, J. and Dalziel, J. M.: Tropical African Plants VII. Kew Bull. Misc. Inform. 1929: 23. 1929.



No. 438. — A species of *Burmannia* in the low forest near Banga

No. 439. — A terrestrial orchid of the woods near Medina

Before leaving this hill and hurrying toward Monrovia, a word should be said concerning its peculiar shape. It is about twice as long as wide and sloping on all but the north side, and that, although well forested, drops off almost vertically for about two hundred feet as though a big slice were cut from the hill. A similar hill was seen near Paiata, but not on such a large scale. If these hills occurred in a more northern country, it might be suggested that glaciation is responsible for this formation, but here only seven and one-half degrees north of the Equator it might be explained as the result of some freak of erosion brought about by subsoil water or a spring.

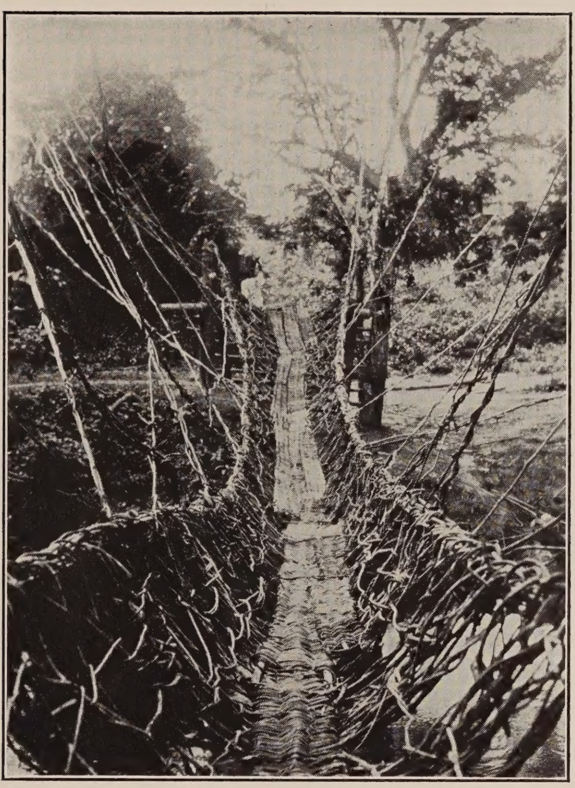
BANGA TO MONROVIA

The trip from Banga to Suehn and Monrovia, because of brevity of time, was made in a series of long marches. As a result, only a small percentage of the flora could be collected.

From Banga to Moylakwelli, the government automobile road in process of construction locally leads through rolling country partly second growth, but mostly primary forest. On the side of the road *Combretum comosum* a liane climbs over tall trees and there produces large numbers of pink flowers. In the town of Moylakwelli, there is a tree of *Ficus* in which are many nests of weaver birds. This tree has a special significance to the townspeople who hold it, and the birds nesting therein, sacred, for it is their belief that as long as the tree flourishes and the birds continue to inhabit it, the town will prosper.

Just outside of the town on the way to Totokwelli, *Afrobrunnichia erecta,* a pink-flowered vine was collected.

With but few short gaps the automobile road continues as far as Belipanimu, where it stops just short of a native suspension bridge made of the stems of the rattan palm. From a hill near Belipanimu there is a fine view to the north over swamps of the raphia and oil palms, to distant hills. Just beyond the hill the road ends and the path goes uphill and down through truly beautiful virgin forests in which the Diana and red Colobus monkeys were seen. At the tops of some of the higher hills there seems to be, as on the summit of the hill at Banga, a definite dominance of certain species of trees. The following were collected in the forests on the ridges: *Salacia senegalensis* a liane which bears caulicolously, panicles of honey-yellow flowers that are three feet long; *Smilax* sp.; *Acacia atoxantha* a prickly-stemmed liane, with finely pinnate leaves, and spikes of white flowers; *Memecylon polyanthemos,* a bush eight to twelve feet high and of which the flowers, in cymes, are white with blue anthers; and two species of *Rinorea, R. prasina* and *R. Elliotii.* In addition to these there are two species of orchids: *Polystachya ensifolia,* and *Listrostachys pellucida,* the last a beautiful species with white pellucid flowers arranged on a long, drooping spike. It is especially striking when seen in the sunlight against the dark background provided by the forest trees, then the inflorescences are chains of living silver. At frequent intervals, and a hundred yards at a time, the air is filled with the delightful fragrance of a tree which unfortunately is not yet classified. Too much cannot be said of the beauty of the forests on



No. 440. — A native suspension bridge made from the rattan palm, at Belipanimu

No. 441. — A view to the north from a hill near Belipanimu. *Raphia* palms in the immediate foreground

the sides of the higher hills and the scenery they provide with the beautiful clear streams flowing through them and tumbling over rocks.

After passing over the high hills near Totokwelli and beyond that town, the terrain becomes much less precipitous and more rolling, but still well forested. At Boporo, we stop to purchase many oranges, limes, and bananas for ourselves, while the boys buy yams and peanuts. At this town a few cocoanut trees grow, the first to be seen near the coast on the Du River. In several places there are a number of cola trees, from around which the underbrush has been removed. On one of these, the orchid *Listrostachys Monteirae* is an epiphyte that produces its pendant spikes of fairly large flowers, which are white with a tinge of salmon-pink. Just before reaching Medina, in gravelly soil, under tall trees, grows a terrestrial orchid related to *Habenaria*, though scattered and but few. In the open swamp *Memecylon spathandra*, the leaves of which have a bluish sheen, are low, branched trees about twenty feet high. A yellow-flowered aquatic species of *Utricularia* floats in a brook in the sunlight.

At Medina, besides mangos, oranges, limes, and bananas, and the staple crop, cassava, a number of cocoa (*Theobroma cacao*) and coffee trees are grown.

From Medina to Bomboma, in fact to Moala (Moyla of map), the tall virgin forests continue and in these a species of *Mapania*, the younger leaves of which are purplish, grows locally in relative abundance. Members of the Acanthaceae appear to be numerous in this region. Between Bapore and Bomboma apocynaceous trees and bushes appear to be especially numerous in the gravelly deeply-shaded forest, or even in more open sandy places. In the latter habitat *Funtumia* sp. is especially abundant and reaches a height of about fifty feet, yet Johnston[1] states that this *F. elastica* is one of the tallest of the African forest and that Mr. Sims reports trees of the same species that are two hundred feet high. In this region around Medina, if any trees attain such a height, they escaped observation, but since a large number of flowers are always present on the ground when the trees are in bloom, it seems hardly likely that such is the case. Other genera of the family as *Alafia, Voacanga* and *Conopharyngia* are also represented as low trees or tall bushes. *Rauwolfia* sp. is freely represented as a low bush in the undergrowth of the tall forests. Aside from the apocynaceous species, the following also occur: *Desmostachys Vogelii,* its white flowers in spirals on long drooping panicles, *Atroxima Afzeliana* a vine, *Dalbergia oblongifolia,* a high bush, and *Acioa Whytei* a bush with drooping branches. Between Bomboma and Moala there is a town called Bamboo Town, so named because of the presence of a great number of bamboo trees. The occurrence of this tree at an elevation of only several hundred feet is of interest because of the fact that in Central Africa a representative of this genus occurs between seven and nine thousand feet. In British Guiana another representative, however, occurs at about six hundred feet elevation. A much rarer plant is *Nymphaea maculata* that grows in pools fed by springs and in the rainy season, a lagoon of an unknown river. The flowers of this resemble those of *N. lotus*, but the outer petals are dull bluish lavender.

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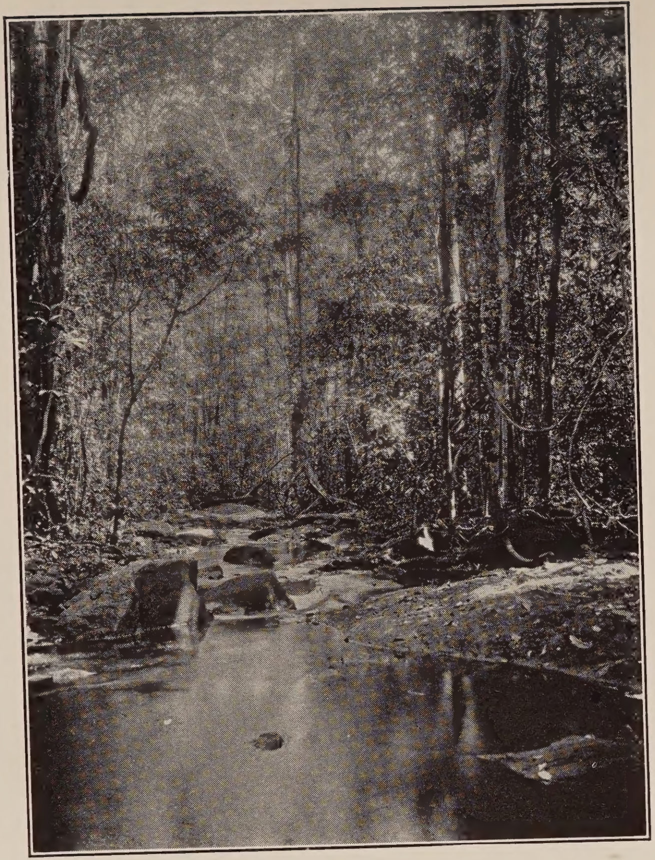
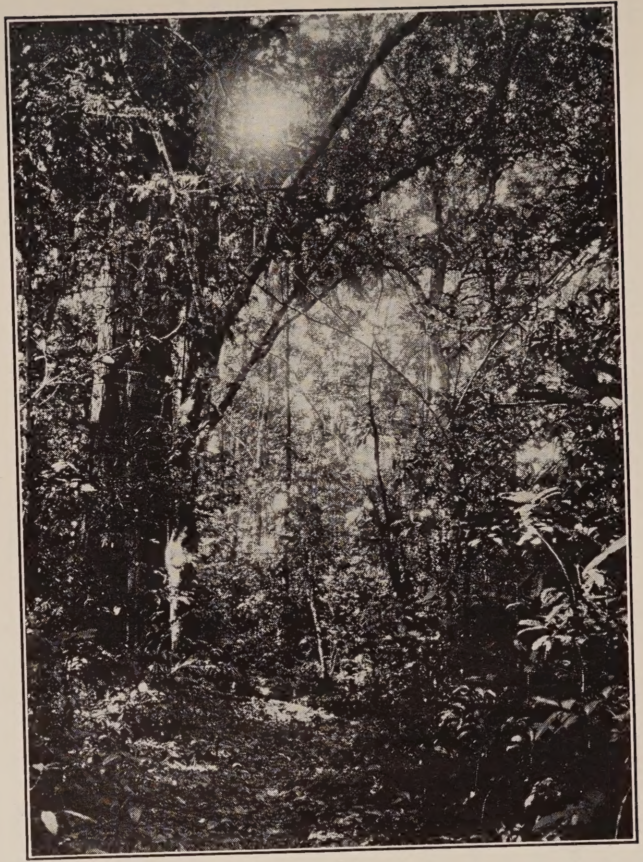
[1] Johnston, H.: *Loc. cit.*, p. 540.



No. 442. — A scene near Moala



No. 443. — A forest scene between Bomboma and Moala

In the vicinity of Boa and Suehn, coffee is cultivated rather extensively and it is quite possible that most of the coffee that is exported from Liberia is raised in this region. Cacao is also grown, but more abundantly near Suehn. The apocynaceous *Callichilia subsessilis*(?) appears in the second growth as a beautiful erect bush that produces fairly large, cream-colored flowers. *Myrianthus arboreus* and *Dichapetalum Linderi* grow in the secondary forest. The latter species has been described by Hutchinson and Dalziel [1] from material collected by the writer. An epiphytic member of the Piperaceae with fleshy leaves that are scarcely more than an inch long, and with flowers in small yellow-green spikes, is used by the Vai in an attempt to cure fits. To accomplish this end, the leaves of this plant are cooked with rice and administered to the patient.

The last species to be remarked upon is *Mussaenda macrosepala*(?). It is a tall, straggling shrub that is conspicuous because of the densely hirsute cymes of large orange-yellow flowers and the prominent, enlarged and light greenish-yellow, leaf-like sepals. This species appears to be confined to a zone extending fifteen to twenty miles back from the coast.

In the above account of the botanical phase of the Harvard African Expedition to Liberia, only a partial picture of the flora of that country can be given since species in such large families as the Rubiaceae, Apocynaceae, Marantaceae, Zingiberaceae, Commelinaceae and others have not as yet been determined. For this reason, the results of collecting are expressed in the following table in numbers gathered:

Trees	182 numbers
Shrubs or bushes	446
Herbs, including orchids	566
Orchids	43
Ferns and clubmosses	60
Mosses and lichens	74
Algae	16
Fungi	214
Total	1601

In conclusion, the writer wishes to express his gratitude to Dr. R. P. Strong, the director of the Expedition, for the privilege of serving as botanist; to Mr. Hill and his associates at Kew for their kindness in communicating the determinations of a portion of the flowering plants that were collected; to Professor Oakes Ames for a partial determination of the species of orchids; to Dr. Joseph Bequaert for his invaluable assistance in the field; and to Dr. George T. Moore, Director of the Missouri Botanical Garden, who by arranging a year's leave of absence, made it possible for the writer to participate in the Expedition.

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[1] Hutchinson, J. and Dalziel, J. M.: Tropical African Plants. Kew Bull. Misc. Inform. 1928 (9). 380.

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